

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of: )  
 )  
Ryoji NOMURA et al. )  
 )  
Serial No.: 10/590,568 )  
 )  
Filed: August 22, 2006 )  
 )  
For: Light Emitting Element And Light )  
Emitting Device Having The Light )  
Emitting Element )  
 )  
Examiner: Dawn L. Garrett )  
 )  
Art Unit: 1794 )  
 )  
Confirmation No.: 8574 )

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**TRANSMITTAL OF VERIFIED ENGLISH TRANSLATION**  
**OF PRIORITY DOCUMENT**

In furtherance of Response B filed on November 25, 2009 and Response C filed herewith, Applicants are submitting herewith a verified English translation of the priority document Japanese patent application serial number 2004-347688 filed November 30, 2004 in Japan.

The present application was filed on August 22, 2006 as the US National stage of PCT application PCT/JP2005/02224 which has an international filing date of November 28, 2005 and claims priority to Japanese patent application serial number 2004-347688 filed November 30, 2004.

Therefore, Applicants are entitled to claim the benefit of the November 30, 2004 filing date

of this priority application.

Conclusion

It is respectfully submitted that the present application is in a condition for allowance and should be allowed.

Please charge our deposit account 50/1039 for any fee due for this submission.

Favorable reconsideration is earnestly solicited.

Date: December 23, 2009

Respectfully submitted,

/Mark J. Murphy/

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In re Patent Application of:	)
Ryoji Nomura et al.	)
Application No.: 10/590,568	) Examiner: D. Garrett
Filed: August 22, 2006	) Group Art Unit: 1794
For: LIGHT EMITTING ELEMENT AND LIGHT	)
EMITTING DEVICE HAVING THE LIGHT	)
EMITTING ELEMENT	)

VERIFICATION OF TRANSLATION

Commissioner for Patents  
P.O.Box 1450  
Alexandria, VA 22313-1450

Sir:

I, Yasuko Iharakumi, C/O Semiconductor Energy Laboratory Co., Ltd. 398, Hase, Atsugi-shi, Kanagawa-ken 243-0036 Japan, a translator, herewith declare:

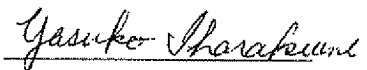
that I am well acquainted with both the Japanese and English Languages;

that I am the translator of the attached English translation of the Japanese Patent Application No. 2004-347688 filed on November 30, 2004; and

that to the best of my knowledge and belief the following is a true and correct English translation of the Japanese Patent Application No. 2004-347688 filed on November 30, 2004.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: this 17<sup>th</sup> day of December, 2009

  
Name: Yasuko Iharakumi

	[Name of Document]	Patent Application
	[Reference Number]	P008357
	[Filing Date]	November 30, 2004, Heisei 16
	[Attention]	Commissioner, Patent Office
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5 [Identification of Handling]

[Number of Prepayment Note] 002543

[Payment Amount] 16000

[List of Attachment]

[Attachment] Scope of Claim 1

10 [Attachment] Specification 1

[Attachment] Drawing 1

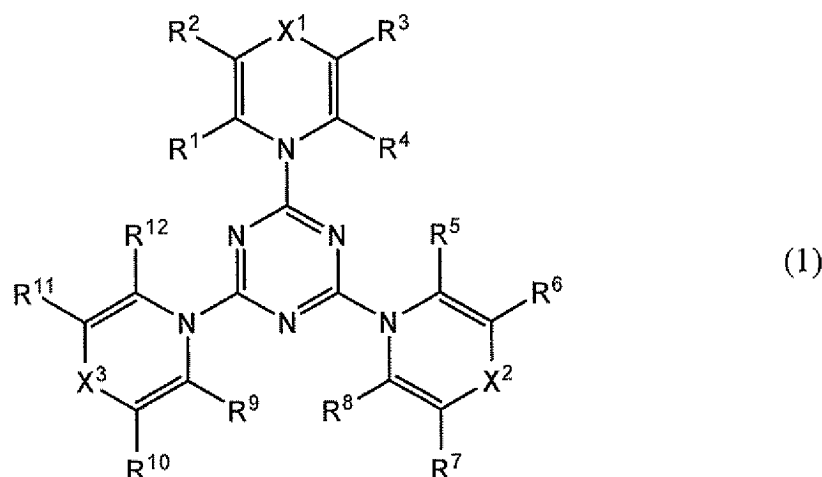
[Attachment] Abstract 1

[Document Name] Scope of Claims

[Claim 1]

1. A light emitting element comprising:  
a pair of electrodes;  
5 a layer between the pair of electrodes, the layer containing a metal oxide and a triazine derivative represented by a general formula (1),

[Chemical Formula 1]



- (wherein, in the general formula (1), R<sup>1</sup> to R<sup>12</sup> are individually independent, or  
10 any of R<sup>1</sup> and R<sup>2</sup>, R<sup>3</sup> and R<sup>4</sup>, R<sup>5</sup> and R<sup>6</sup>, R<sup>7</sup> and R<sup>8</sup>, R<sup>9</sup> and R<sup>10</sup>, and R<sup>11</sup> and R<sup>12</sup> is bonded to form a ring,

- when R<sup>1</sup> to R<sup>12</sup> are individually independent, R<sup>1</sup> to R<sup>12</sup> are individually any one  
of hydrogen, an alkyl group having 1 to 6 carbon atoms, an alkoxy group having 1 to 6  
carbon atoms, a halogen group, an acyl group having 1 to 6 carbon atoms, an  
15 alkoxycarbonyl group having 1 to 6 carbon atoms, an aryl group having 6 to 30 carbon  
atoms, preferably 6 to 14 carbon atoms, and a heteroaromatic group having 2 to 18  
carbon atoms, preferably 2 to 14 carbon atoms,

- the heteroaromatic group has a monocyclic structure of a 5-membered ring, a  
monocyclic structure of a 6-membered ring, a polycyclic structure containing any one  
20 of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a  
5-membered ring and a 6-membered ring, and contains an atom which is any of  
nitrogen, oxygen, and sulfur,

when any of R<sup>1</sup> and R<sup>2</sup>, R<sup>3</sup> and R<sup>4</sup>, R<sup>5</sup> and R<sup>6</sup>, R<sup>7</sup> and R<sup>8</sup>, R<sup>9</sup> and R<sup>10</sup>, and R<sup>11</sup>

and R<sup>12</sup> is bonded to form a ring, the ring is any one of an aromatic ring, a heterocycle and an alicycle,

a bond of R<sup>1</sup> and R<sup>2</sup>, a bond of R<sup>3</sup> and R<sup>4</sup>, a bond of R<sup>5</sup> and R<sup>6</sup>, a bond of R<sup>7</sup> and R<sup>8</sup>, a bond of R<sup>9</sup> and R<sup>10</sup>, and a bond of R<sup>11</sup> and R<sup>12</sup> are individually independent,

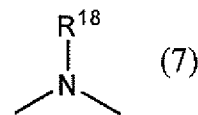
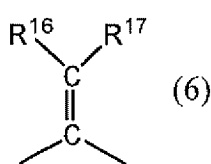
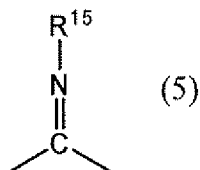
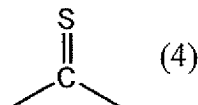
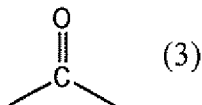
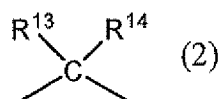
- 5 R<sup>1</sup> and R<sup>2</sup> are bonded to form any one of an aromatic ring, a heterocycle, and an alicycle, and R<sup>3</sup> to R<sup>12</sup> are individually hydrogen or a substituent,

the aromatic ring is condensed with another aromatic ring,

the aromatic ring, the heterocycle, or the alicycle individually have a substituent such as an oxo group or an alkyl group having 1 to 6 carbon atoms, and

- 10 X<sup>1</sup>, X<sup>2</sup>, and X<sup>3</sup> individually indicate any one of groups of formulas (2) to (7),

[Chemical Formula 02]



- 15 wherein, in a group represented by the formula (2), R<sup>13</sup> and R<sup>14</sup> is individually independent, or bonded to form a ring,

when R<sup>13</sup> and R<sup>14</sup> are individually independent, R<sup>13</sup> and R<sup>14</sup> individually represent hydrogen, an alkyl group having 1 to 6 carbon atoms, an aryl group having 6 to 30 carbon atoms, preferably 6 to 14 carbon atoms, and a heteroaromatic group having 2 to 18 carbon atoms, preferably 2 to 10 carbon atoms,

- 20 in the formula (2), the aryl group and the heteroaromatic group individually have a substituent,

- the heteroaromatic group has a monocyclic structure of a 5-membered ring or a 6-membered ring, a polycyclic structure containing any one of or both a 5-membered ring and a 6-membered ring, and contains an atom which is any of nitrogen, oxygen, and sulfur, and
- 25

when R<sup>13</sup> and R<sup>14</sup> are bonded to form a ring, the ring is an alicycle having 3 to 10 carbon atoms, preferably 6 carbon atoms,

wherein, in a group represented by the formula (5), R<sup>15</sup> is any one of hydrogen, an aryl group having 6 to 30 carbon atoms, preferably 6 to 14 carbon atoms, and a  
5 heteroaromatic group having 2 to 18 carbon atoms, preferably 2 to 10 carbon atoms,

in the formula (5), the aryl group has one or two or more substituents such as an alkyl group having 1 to 6 carbon atoms, an acyl group having 1 to 6 carbon atoms, a halogen group, and an oxo group, or unsubstituted, and

the heteroaromatic group has a monocyclic structure of a 5-membered ring, a  
10 monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring, and contains an atom which is any of nitrogen, oxygen, and sulfur,

wherein in a group represented by the formula (6), R<sup>16</sup> and R<sup>17</sup> are individually  
15 independent, and represent hydrogen, an aryl group having 6 to 30 carbon atoms, a heteroaromatic group having 2 to 18 carbon atoms, preferably 2 to 10 carbon atoms, and a cyano group,

in the formula (6), the aryl group has one or two or more substituents such as an alkyl group having 1 to 6 carbon atoms, a halogen group, and an aryl group having 6  
20 to 30 carbon atoms, preferably 6 to 14 carbon atoms, or unsubstituted, and

the heteroaromatic group has a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring, and contains an atom which is any of nitrogen,  
25 oxygen, and sulfur,

wherein, in a group represented by the formula (7), R<sup>18</sup> represents hydrogen, an alkyl group having 1 to 6 carbon atoms, an aryl group having 6 to 30 carbon atoms, preferably 6 to 14 carbon atoms, and a heteroaromatic group having 2 to 18 carbon atoms, preferably 2 to 10 carbon atoms,

30 in the formula (7), the aryl group has a substituent such as a dialkylamino group, and

the heteroaromatic group has a monocyclic structure of a 5-membered ring, a



monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring, and contains an atom which is any of nitrogen, oxygen, and sulfur.)

5

2. The light emitting element according to claim 1, wherein the metal oxide is a molybdenum oxide, a vanadium oxide, a lithium oxide, or a rhenium oxide.

3. The light emitting element according to claim 1 or 2, wherein a triazine  
10 derivative represented by the general formula (1) and a luminescent material having an emission wavelength in the bandwidth from 400 nm to 500 nm are contained between the pair of electrodes.

4. A light emitting device comprising:  
15 a semiconductor film;  
a pair of electrodes provided over the semiconductor film; and  
a first layer, a second layer, and third layer, which are provided over the pair of electrodes in this order,

wherein any of the first to third layers includes a layer containing a triazine  
20 derivative represented by the general formula (1) and a metal oxide.

5. The light emitting device according to claim 4, wherein the metal oxide is a molybdenum oxide, a vanadium oxide, a lithium oxide, or a rhenium oxide.

25 6. The light emitting device according to claim 4 or 5, wherein a triazine derivative represented by the general formula (1) and a luminescent material having an emission wavelength in the bandwidth from 400 nm to 500 nm are contained between the pair of electrodes.

[Document Name]            Specification

[Title of the Invention]    LIGHT EMITTING ELEMENT AND LIGHT EMITTING  
DEVICE HAVING THE LIGHT EMITTING ELEMENT

[Technical Field to which the Invention pertains]

5    [0001]

The present invention relates to a structure of a light emitting element including a triazine derivative, and also relates to a light emitting device having the light emitting element.

[Prior Art]

10   [0002]

Many of light emitting elements that are used in displays and the like have a structure in which a layer containing a luminescent material is sandwiched between a pair of electrodes. In these light emitting elements, light is emitted when an exciton formed by recombination of an electron injected from one of the electrodes and a hole  
15 injected from the other electrode returns to the ground state.

[0003]

In the field of light emitting elements, the structure of a layer containing a luminescent material, a novel material for forming a layer containing a luminescent material, and the like have been developed in order to obtain a light emitting element  
20 that is superior in luminous efficiency and chromaticity or is able to prevent quenching or the like.

[0004]

For example, for the structure of a layer containing a luminescent material, a multilayer structure composed of a combination of a layer containing a highly carrier  
25 injecting substance, a layer containing a highly carrier transporting substance, and the like is proposed so that a light emitting region is formed in a region away from an electrode. Further, as for a highly carrier transporting substance, for example, a triazine derivative disclosed in Patent document 1 or Patent document 2 is proposed.

[Patent document 1] Japanese Published Patent Application No. H7-157473

30        [Patent document 2] Japanese Published Patent Application No. H8-1199163

[Disclosure of Invention]

[Problems to be Solved by the Invention]

[0005]

In view of the circumstances described above, it is an object of the present invention to provide a light emitting device having a luminescence property.

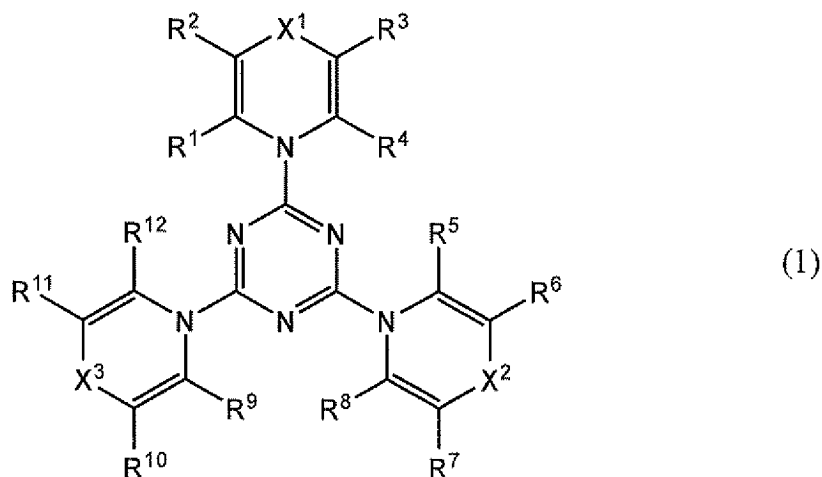
5 [Means for Solving the Problem]

[0006]

In view of the object described above, the present invention has a feature of a light emitting element including a pair of electrodes, and a layer containing a triazine derivative represented by a general formula (1) and a metal oxide that is an inorganic  
10 compound which are provided between the pair of electrodes.

[0007]

[Chemical Formula 01]



[0008]

15 In the general formula (1), R<sup>1</sup> to R<sup>12</sup> are individually independent, or any one of R<sup>1</sup> and R<sup>2</sup>, R<sup>3</sup> and R<sup>4</sup>, R<sup>5</sup> and R<sup>6</sup>, R<sup>7</sup> and R<sup>8</sup>, R<sup>9</sup> and R<sup>10</sup>, and R<sup>11</sup> and R<sup>12</sup> is bonded to form a ring. Here, when R<sup>1</sup> to R<sup>12</sup> are individually independent, R<sup>1</sup> to R<sup>12</sup> are individually any one of hydrogen, an alkyl group having 1 to 6 carbon atoms, an alkoxy group having 1 to 6 carbon atoms, a halogen group, an acyl group having 1 to 6 carbon  
20 atoms, an alkoxycarbonyl group having 1 to 6 carbon atoms, an aryl group having 6 to 30 carbon atoms (preferably, 6 to 14 carbon atoms), and a heteroaromatic group having 2 to 18 carbon atoms (preferably, 2 to 14 carbon atoms). It is to be noted that

the alkyl group includes an aliphatic heteroaromatic group in the present invention. However, it is preferable to use a chain alkyl group because handling is easy. The preferable number of carbon atoms in the aryl group and the heteroaromatic group is determined in consideration of a raw material and easiness of handling thereof.

5 [0009]

Further, it is preferable that the heteroaromatic group have a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring. Furthermore, the heteroaromatic group contains an atom which is any of nitrogen, oxygen, and sulfur.

[0010]

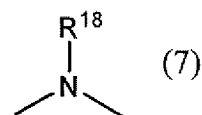
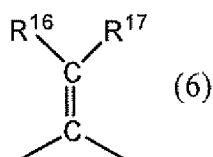
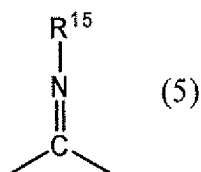
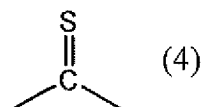
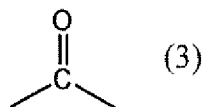
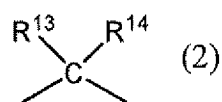
In addition, when  $R^1$  and  $R^2$ ,  $R^3$  and  $R^4$ ,  $R^5$  and  $R^6$ ,  $R^7$  and  $R^8$ ,  $R^9$  and  $R^{10}$ , and  $R^{11}$  and  $R^{12}$  are individually bonded to form rings, those rings are individually any one of an aromatic ring, a heterocycle, and an alicycle. In this case, the bond of  $R^1$  and  $R^2$ , the bond of  $R^3$  and  $R^4$ , the bond of  $R^5$  and  $R^6$ , the bond of  $R^7$  and  $R^8$ , the bond of  $R^9$  and  $R^{10}$ , and the bond of  $R^{11}$  and  $R^{12}$  are individually independent. For example,  $R^1$  and  $R^2$  may be bonded to form any one of an aromatic ring, a heterocycle, and an alicycle, and then,  $R^3$  to  $R^{12}$  may be individually hydrogen or a substituent. In addition, the aromatic ring may be condensed with another aromatic ring. The aromatic ring, the heterocycle, and the alicycle may individually have a substituent such as an oxo group and an alkyl group having 1 to 6 carbon atoms. It is to be noted that the alkyl group includes an aliphatic heteroaromatic group in the present invention. However, it is preferable to use a chain alkyl group because handling is easy.

25 [0011]

In the general formula (1),  $X^1$ ,  $X^2$ , and  $X^3$  individually represent a group which is any one of formulas (2) to (7).

[0012]

[Chemical Formula 02]



[0013]

In the group represented by the formula (2),  $R^{13}$  and  $R^{14}$  may be individually independent, or bonded to form a ring. When  $R^{13}$  and  $R^{14}$  are individually independent,  $R^{13}$  and  $R^{14}$  individually represent hydrogen, an alkyl group having 1 to 6 carbon atoms, an aryl group having 6 to 30 carbon atoms (preferably, 6 to 14 carbon atoms), or a heteroaromatic group having 2 to 18 carbon atoms (preferably, 2 to 10 carbon atoms). It is to be noted that the alkyl group includes an aliphatic heteroaromatic group in the present invention. However, it is preferable to use a chain alkyl group because handling is easy. The preferable number of carbon atoms in the aryl group and the heteroaromatic group is determined in consideration of a raw material and easiness of handling thereof. In addition, the aryl group and the heteroaromatic group may individually have a substituent. Further, it is preferable that the heteroaromatic group have a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring. Furthermore, the heteroaromatic group contains an atom which is any of nitrogen, oxygen, and sulfur.

[0014]

Alternatively, when  $R^{13}$  and  $R^{14}$  are bonded to form a ring, the ring is an alicycle having 3 to 10 carbon atoms (preferably, 6 carbon atoms). Preferable number of carbon atoms in the alicycle is determined in consideration of a raw material and easiness of handling thereof. When the number of carbon atoms in the alicycle is much increased, the melting point (Tg) of the compound may be greatly decreased, and it may be thus difficult in handling.

[0015]

In the group represented by the formula (5),  $R^{15}$  is any one of hydrogen, an aryl group having 6 to 30 carbon atoms (preferably, 6 to 14 carbon atoms), and a heteroaromatic group having 2 to 18 carbon atoms (preferably, 2 to 10 carbon atoms).  
5 The preferable number of carbon atoms in the aryl group and the heteroaromatic group is determined in consideration of a raw material and easiness of handling thereof. Here, the aryl group may have one or more substituents of an alkyl group having 1 to 6 carbon atoms, an acyl group having 1 to 6 carbon atoms, a halogen group, an oxo group, and the like, or may be unsubstituted. It is to be noted that the alkyl group includes an  
10 aliphatic heteroaromatic group in the present invention. However, it is preferable to use a chain alkyl group because handling is easy. It is preferable that the heteroaromatic group have a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a  
15 5-membered ring and a 6-membered ring. Furthermore, the heteroaromatic group contains an atom which is any of nitrogen, oxygen, and sulfur.

[0016]

In the group represented by the formula (6),  $R^{16}$  and  $R^{17}$  are individually independent, and represent hydrogen, an aryl group having 6 to 30 carbon atoms, a  
20 heteroaromatic group having 2 to 18 carbon atoms (preferably, 2 to 10 carbon atoms), or a cyano group. Preferable number of carbon atoms in the heteroaromatic group is determined in consideration of a raw material and easiness of handling thereof. Here, the aryl group may have one or more substituents of an alkyl group having 1 to 6 carbon atoms, a halogen group, an aryl group having 6 to 30 carbon atoms (preferably, 6 to 14  
25 carbon atoms), and the like, or may be unsubstituted. It is to be noted that the alkyl group includes an aliphatic heteroaromatic group in the present invention. However, it is preferable to use a chain alkyl group because handling is easy. The preferable number of carbon atoms in the aryl group is determined in consideration of a raw material and easiness of handling thereof. It is preferable that the heteroaromatic  
30 group have a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a

6-membered ring. Furthermore, the heteroaromatic group contains an atom which is any of nitrogen, oxygen, and sulfur.

[0017]

In the group represented by the formula (7),  $R^{18}$  represents hydrogen, an alkyl group having 1 to 6 carbon atoms, an aryl group having 6 to 30 carbon atoms (preferably, 6 to 14 carbon atoms), or a heteroaromatic group having 2 to 18 carbon atoms (preferably, 2 to 10 carbon atoms). It is to be noted that the alkyl group includes an aliphatic heteroaromatic group in the present invention. However, it is preferable to use a chain alkyl group because handling is easy. The preferable number of carbon atoms in the aryl group and the heteroaromatic group is determined in consideration of a raw material and easiness of handling thereof. Here, the aryl group may have a substituent such as a dialkylamino group. It is preferable that the heteroaromatic group have a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring. Furthermore, the heteroaromatic group contains an atom which is any of nitrogen, oxygen, and sulfur.

[0018]

In the light emitting element according to the present invention, a metal oxide, or a metal nitride and a metal nitride oxide including the metal oxides may be used.

[0019]

As a specific material for the case of having a function as an electron accepting substance, an oxide of a transition metal belonging to any one of Groups 4 to 12 of the periodic table can be used. Above all, many of the oxides of transition metals belonging to any one of Groups 4 to 8 of the periodic table have a high electron accepting property. In particular, vanadium oxide, molybdenum oxide, niobium oxide, rhenium oxide, tungsten oxide, ruthenium oxide, titanium oxide, chromium oxide, zirconium oxide, hafnium oxide, and tantalum oxide are suitable.

[0020]

Further, as the metal mentioned above for the case of having a function as an electron donating substance, a substance selected from alkali metals and alkaline earth metals, specifically, lithium (Li), calcium (Ca), sodium (Na), potassium (K), magnesium

(Mg), and the like can be used. Specific materials include oxides of the alkali metals or the alkaline earth metals mentioned above, nitrides of the alkali metals, nitrides of the alkaline earth metals, and the like, specifically, lithium oxide ( $\text{Li}_2\text{O}$ ), calcium oxide ( $\text{CaO}$ ), sodium oxide ( $\text{Na}_2\text{O}$ ), potassium oxide ( $\text{K}_2\text{O}$ ), magnesium oxide ( $\text{MgO}$ ),  
5 lithium fluoride ( $\text{LiF}$ ), cesium fluoride ( $\text{CsF}$ ), calcium fluoride ( $\text{CaF}_2$ ), and the like may be used.

[0021]

Further, it is preferable that the light emitting element according to the present invention have a layer in which a triazine derivative according to the present invention  
10 and a metal oxide that is an inorganic compound are mixed, or a layer in which the triazine derivative and the metal oxide that is an inorganic compound are stacked (hereinafter, referred to as a mixed layer collectively).

[0022]

Such a triazine derivative according to the present invention can be used as a  
15 electron generating layer or a light emitting layer in the light emitting element.

[0023]

When the triazine derivative according to the present invention is used for a electron generating layer, in the case of forming a mixed layer, lithium oxide ( $\text{Li}_2\text{O}$ ), calcium oxide ( $\text{CaO}$ ), sodium oxide ( $\text{Na}_2\text{O}$ ), potassium oxide ( $\text{K}_2\text{O}$ ), magnesium oxide  
20 ( $\text{MgO}$ ), lithium fluoride ( $\text{LiF}$ ), cesium fluoride ( $\text{CsF}$ ), and calcium fluoride ( $\text{CaF}_2$ ) can be used as a metal fluoride.

[0024]

When the triazine derivative according to the present invention is used for a light emitting layer, the light emitting element has the triazine derivative represented by  
25 the general formula (1) and a luminescent material having an emission wavelength in the bandwidth of 400 nm to 500 nm between a pair of electrodes. It is to be noted that the triazine derivative according to the present invention can be used for either a host or a dopant.

[0025]

30 Further, the present invention has a feature of a light emitting device that has the light emitting element described above.

[Effect of the Invention]



[0026]

By having a triazine derivative according to the present invention and a metal oxide that is an inorganic compound, a light emitting element that operates at a lower driving voltage can be obtained even when the element is made thicker.

5 [0027]

Further, by using a triazine derivative according to the present invention for a light emitting layer, a light emitting element that is capable of exhibiting a luminescent color that is closer to a luminescent color derived from a luminescent material can be obtained.

10 [0028]

Accordingly, by applying a light emitting element including a triazine derivative according to the present invention to a pixel, a light emitting device that is capable of displaying an image with favorable color reproducibility can be obtained.

[0029]

15 Further, according to the present invention, a novel substance for manufacturing a light emitting element can be obtained, and then a light emitting element that has a new structure can be provided. Therefore, the range of material choice can be expanded when a light emitting element is manufactured.

[Best Mode for Carrying out the Invention]

20 [0030]

Embodiments of the present invention will be described specifically with reference to the accompanying drawings as below. However, the present invention is easily understood by those skilled in the art that various changes and modifications are possible, unless such changes and modifications depart from the content and the scope of the invention. Therefore, the present invention is not construed as being limited to the description of the following Embodiments.

It is to be noted that the same portion or a portion having the same function is denoted by the same reference numeral in all the drawings for describing Embodiments, and the description thereof is omitted.

30 [0031]

The triazine derivative according to the present invention mentioned includes

- 2,4,6-tris(9-oxo-10(9H)-acridinyl)-1,3,5-triazine,  
 2,4,6-tris(9-oxo-12(7H)-benzo[a]acridinyl)-1,3,5-triazine,  
 2,4,6-tris(2-chloro-9-oxo-10(9H)-acridinyl)-1,3,5-triazine,  
 2,4,6-tris(3-methoxy-9-oxo-10(9H)-acridinyl)-1,3,5-triazine,  
 5 2,4,6-tris(2-methoxy-9-oxo-10(9H)-acridinyl)-1,3,5-triazine,  
 2,4,6-tris(10-phenyl-dihydrophenazin-5-yl)-1,3,5-triazine,  
 2,4,6-tris(10-phenyl-benzo[a]dihydrophenazin-5-yl)-1,3,5-triazine,  
 2,4,6-tris(10-phenyl-dibenzo[a,c]dihydrophenazin-5-yl)-1,3,5-triazine,  
 2,4,6-tris(10-phenyl-dibenzo[a,i]dihydrophenazin-5-yl)-1,3,5-triazine,  
 10 2,4,6-tris(10-methyl-dihydrophenazin-5-yl)-1,3,5-triazine,  
 2,4,6-tris[10-(4-dimethylamino)phenyl-dihydrophenazin-5-yl]-1,3,5-triazine,  
 2,4,6-tris[10-(2-pyridyl)-dihydrophenazin-5-yl]-1,3,5-triazine,  
 2,4,6-tris[10-(2-thienyl)-dihydrophenazin-5-yl]-1,3,5-triazine,  
 2,4,6-tris[10-(1-naphthyl)-dihydrophenazin-5-yl]-1,3,5-triazine,  
 15 2,4,6-tris[9-(phenylimino)-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris[9-(1-naphthylimino)-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris[9-(1-anthryl)-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris[9-(fluorophenylimino)-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris[9-(methoxyphenylimino)-10(9H)-acridinyl]-1,3,5-triazine,  
 20 2,4,6-tris[9-(tolylimino)-10(9H)-acridinyl]-1,3,5-triazine, 2,4,6-tris[9-N-{1,8-naphthalic  
 anhydride-4-yl}imino-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris[9-(2-pyridylimino)-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris[9-N-(1,3-benzothiazole-2-yl)imino-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris(9-benzylidene-10(9H)-acridinyl)-1,3,5-triazine,  
 25 2,4,6-tris[9-(2-naphthylidene)-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris[9-(anthracene-9-ylidene)-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris[9-(diphenylmethylenidene)-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris[9-(2-biphenylidene)-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris[9-(methylbenzylidene)-10(9H)-acridinyl]-1,3,5-triazine,  
 30 2,4,6-tris[9-(fluorobenzylidene)-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris[9-(2-pyridylidene)-10(9H)-acridinyl]-1,3,5-triazine,

- 2,4,6-tris[9-(2-thienylidene)-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris(9,9-diphenyl-9,10-dihydro-9-acridinyl)-1,3,5-triazine,  
 2,4,6-tris[9-(dicyanomethylidene)-10(9H)-acridinyl]-1,3,5-triazine,  
 2,4,6-tris(3-methoxy-4(1H)-pyridinon-1-yl)-1,3,5-triazine,  
 5 2,4,6-tris(3,4-dicyano-2,6-dimethyl-4(1H)-pyridinon-1-yl)-1,3,5-triazine,  
 2,4,6-tris(2,6-dimethoxycarbonyl-4(1H)-pyridinon-1-yl)-1,3,5-triazine,  
 2,4,6-tris[2,6-bis(2-pyridyl)-4(1H)-pyridinon-1-yl]-1,3,5-triazine,  
 2,4,6-tris(3,5-diacetyl-2,6-dimethyl-1,4-dihydropyridin-1-yl)-1,3,5-triazine,  
 2,4,6-tris(3,5-diethoxycarbonyl-2,6-dimethyl-1,4-dihydropyridin-1-yl)-1,3,5-triazine,  
 10 2,4,6-tris[3,3,6,6-tetramethyl-3,4,6,7,9,10-hexahydro-1,8(2H,5H)-acridinedion-10-yl]-1,  
 3,5-triazine,  
 2,4,6-tris(3,5-dicyano-2,4,4,6-tetramethyl-1,4-dihydropyridin-1-yl)-1,3,5-triazine,  
 2,4,6-tris(1,5-dicyano-2,4-dimethyl-3-azaspiro[5,5]undeca-1,4-dien-1-yl)-1,3,5-triazine,  
 2,4,6-tris(3,5-dicyano-2,6-dimethyl-4-phenyl-1,4-dihydropyridin-1-yl)-1,3,5-triazine,  
 15 2,4,6-tris[3,5-dicyano-4-(2-furyl)-2,6-dimethyl-1,4-dihydropyridin-1-yl]-1,3,5-triazine,  
 2,4,6-tris[3,5-dicyano-2,6-dimethyl-4-(3-pyridyl)-1,4-dihydropyridin-1-yl]-1,3,5-triazin  
 e,  
 2,4,6-tris[3,5-dicyano-2,6-dimethyl-4-(2-thienyl)-1,4-dihydropyridin-1-yl]-1,3,5-triazine,  
 2,4,6-tris[9-isopropyl-3,4,6,7,9,10-hexahydro-1,8(2H,5H)-acridinedion-1-yl]-1,3,5-triaz  
 20 ine, and  
 2,4,6-tris{8-phenyl-5,8-dihydro-1H,3H-difuro[3,4-b:3,4-e]pyridine-1,7(4H)-dion-1-yl}-  
 1,3,5-triazine.

[0032]

Then, a light emitting element in which at least one of the triazine derivatives  
 25 mentioned above and a metal oxide that is an inorganic compound are provided between  
 a pair of electrodes can be manufactured. In this case, a layer in which the triazine  
 derivative and the metal oxide are mixed is preferably formed.

[0033]

By mixing a triazine derivative and a metal oxide in a layer, increasing of  
 30 driving voltage can be prevented even if a film of the layer is thickened.

[0034]

It is not limited to a layer in which the triazine derivative and the metal oxide

are mixed. When a layer in which another organic compound and the metal oxide are mixed is provided in addition to a layer including a triazine derivative, increase in the driving voltage due to thickening the layer including the metal oxide can be prevented .

[0035]

5 In general, it is not preferable that a layer of a light emitting element be made thicker because the driving voltage is increased. However, in a light emitting element including an extremely thin film, a short circuit between electrodes can be prevented by thickening, and improvement of mass-productivity is expected. Then, inventors have found out that increase in driving voltage can be prevented by forming a layer in which  
10 an organic compound and a metal oxide that is an inorganic compound are mixed between a pair of electrodes even when a layer of a light emitting element is made thicker.

[0036]

Vanadium oxide, molybdenum oxide, niobium oxide, rhenium oxide, tungsten  
15 oxide, ruthenium oxide, titanium oxide, chromium oxide, zirconium oxide, hafnium oxide, and tantalum oxide are suitable for such metal oxide. These materials function as an electron accepting substance.

[0037]

As an electron donating substance, lithium oxide ( $\text{Li}_2\text{O}$ ), calcium oxide ( $\text{CaO}$ ),  
20 sodium oxide ( $\text{Na}_2\text{O}$ ), potassium oxide ( $\text{K}_2\text{O}$ ), magnesium oxide ( $\text{MgO}$ ), cesium fluoride ( $\text{CsF}$ ), calcium fluoride ( $\text{CaF}_2$ ), and the like can be given.

[0038]

In the light emitting element according to the present invention, metal nitride or metal nitride oxide having the metal element can be used in addition to the metal oxide  
25 mentioned above.

[0039]

Accordingly, a layer included in a light emitting element is made thicker, a short circuit between electrodes can be prevented, and the mass-productivity can be improved, which are much preferable.

30 [0040]

Further, the layer in which the triazine derivative according to the present invention and a metal oxide are mixed can be manufactured by a co-evaporation method.

In specific, the co-evaporation of resistance-heating evaporations, the co-evaporation of electron beam evaporations, and the co-evaporation of the resistance-heating evaporation and the electron beam evaporation can be cited. The mixed layer described above can be formed by combining similar type methods.

- 5 Further, a different type method may be combined with the evaporation method. For example, deposition of the resistance-heating evaporation and sputtering, the deposition of the electron beam evaporation and sputtering, and the like can be used. The above example shows a layer including two kinds of materials of a triazine derivative and a metal oxide. However, in the case of a layer including three or more kinds of materials,  
10 the layer can be formed by combining the similar type and the different type methods.

[0041]

(Embodiment 1)

In the present embodiment, a structure of a light emitting element having a triazine derivative according to the present invention will be described.

- 15 [0042]

A light emitting element according to the present invention, as shown in FIG 1, has a first electrode 101 and a second electrode 102 which are opposed to each other, and has a first layer 111, a second layer 112, and a third layer 113 which are stacked in this order from the first electrode 101. When a voltage is applied to such a light  
20 emitting element so that the potential of the first electrode 101 is higher than that of the second electrode 102, holes are injected into the second layer 112 from the first layer 111, and electrons are injected into the second layer 112 from third layer 113. The holes and the electrons are recombined in the second layer 112 to excite a luminescent material. Then, light is emitted when the luminescent material in the excited state  
25 returns to the ground state.

[0043]

Next, the first layer 111 to the third layer 113, the first electrode 101, and the second electrode 102 will be described.

[0044]

- 30 The first layer 111 is a hole generating layer. As such a layer, for example, a layer containing a hole transporting substance and a substance that exhibits an electron accepting property with respect to the substance can be cited. Further, it is preferable

that the substance that exhibits the electron accepting property with respect to the hole transporting substance be included so that a molar ratio with respect to that of the hole transporting substance (= the material having the electron accepting property with respect to the material with the hole transporting property / the substance with the hole transporting property) is 0.5 to 2.

[0045]

The hole transporting substance is a substance, a transporting property of which is higher than an electron transporting property. For example, organic compounds such as aromatic amine compounds such as  
10 4,4'-bis[N-(1-naphthyl)-N-phenylamino] biphenyl (abbreviation:  $\alpha$ -NPD),  
4,4'-bis[N-(3-methylphenyl)-N-phenylamino]biphenyl (abbreviation: TPD),  
4,4',4''-tris(N,N-diphenylamino)triphenylamine (abbreviation: TDATA),  
4,4',4''-tris[N-(3-methylphenyl)-N-phenylamino]triphenylamine (abbreviation: MTDATA), and 4,4'-bis[N-{4-(N,N-di-m-tolylamino)phenyl}-N-phenylamino]biphenyl  
15 (abbreviation: DNTPD), and phthalocyanine compounds such as phthalocyanine (abbreviation: H<sub>2</sub>Pc), copper phthalocyanine (abbreviation: CuPc), and vanadyl phthalocyanine (abbreviation: VOPc) can be used. It is to be noted that the hole transporting substance is not limited to these.

[0046]

20 Further, an oxide of a transition metal belonging to any one of Groups 4 to 12 of the periodic table can be used for the substance that exhibits the electron accepting property with respect to the hole transporting substance. Above all, many oxides of transition metals belonging to any one of Groups 4 to 8 have a high electron accepting property. In particular, vanadium oxide, molybdenum oxide, niobium oxide, rhenium  
25 oxide, tungsten oxide, ruthenium oxide, titanium oxide, chromium oxide, zirconium oxide, hafnium oxide, and tantalum oxide are suitable. It is to be noted that the substance that exhibits the electron accepting property with respect to the hole transporting substance is not limited to these.

[0047]

30 The first layer 111 can be formed by an evaporation method. In the case of forming a mixed layer, a co-evaporation method can be used. For example, the first

layer 111 in which a hole transporting substance and a substance (the metal oxide described above as an example) that exhibits an electron accepting property with respect to the substance are included can be manufactured by a co-evaporation method. As the evaporation method for forming the first layer 111, similar type and different type  
5 methods such as a co-evaporation method of resistance-heating evaporations, a co-evaporation method of electron beam evaporations, a co-evaporation method of resistance-heating evaporation and electron beam evaporation, deposition of resistance-heating evaporation and sputtering, and deposition of electron beam evaporation and sputtering can be combined. Although the above example is applied  
10 to a layer including two kinds of materials, a layer including of three or more kinds of materials can also be formed by combining the similar type and the different type methods as mentioned above.

[0048]

It is to be noted that the first layer 111 may include another organic compound.  
15 Rubrene and the like can be cited as another organic compound. The reliability can be improved by adding rubrene.

[0049]

In addition, the first layer 111 may be a layer composed of a metal oxide such as molybdenum oxide, vanadium oxide, ruthenium oxide, cobalt oxide, and copper  
20 oxide.

[0050]

It is preferable that the first layer 111 be formed from a layer having an organic compound and a metal oxide as described above because the conductivity is higher. When the conductivity is higher, the first layer can be made thicker.

25 [0051]

Further, crystallization of an organic compound layer can be suppressed by using a layer having an organic compound and a metal oxide, and the organic compound layer can be thus formed to be thicker without increase in resistance. Therefore, even when there is irregularity due to dust, contamination, and the like on a substrate, the  
30 organic compound layer is hardly affected by the irregularity because the organic compound layer is made thicker. Thus, defects such as a short caused by the irregularity can be prevented.

[0052]

The second layer 112 is a layer including a light emitting layer. The layer including the light emitting layer may be a single layer composed of only the light emitting layer or a multilayer. A specific multilayer includes a plurality of layers selected from an electron transporting layer, a hole transporting layer, and a hole injecting layer in addition to the light emitting layer. FIG. 1 shows a case in which the second layer 112 is a multilayer including an electron transporting layer 124 and a hole transporting layer 122 in addition to a light emitting layer 123.

[0053]

It is preferable that the light emitting layer be a layer in which a luminescent material is dispersed in a material that has a larger energy gap than the luminescent material. However, the light emitting layer is not limited to this. It is to be noted that the energy gap indicates the energy gap between the LUMO level and the HOMO level. Further, a material that provides a favorable luminous efficiency and is capable of emitting light with a desired wavelength may be used for the luminescent material.

[0054]

The triazine derivative according to the present invention can be used as a luminescent material and a material that has a larger energy gap than that of the luminescent material.

[0055]

As a material that is used for dispersing the luminescent material, for example, in addition to an anthracene derivative such as 9,10-di(2-naphthyl)-2-tert-butylanthracene (abbreviation: t-BuDNA) or a carbazole derivative such as 4,4'-bis(N-carbazolyl)biphenyl (abbreviation: CBP), metal complexes such as bis[2-(2-hydroxyphenyl)pyridinato]zinc (abbreviation: Znpp<sub>2</sub>) and bis[2-(2-hydroxyphenyl)benzoxazolato]zinc (abbreviation: ZnBOX), and the like can be used. However, the material used for dispersing the luminescent material is not limited to these materials. When the light emitting layer is dispersed as described above, quenching of luminescence from the luminescent material due to the concentration can be prevented.

[0056]

In order to exhibit white light emission from such a second layer 112, for



example, a structure in which, from the first electrode 101, TPD (aromatic diamine), 3-(4-tert-butylphenyl)-4-phenyl-5-(4-biphenyl)-1,2,4-triazole (abbreviated: TAZ), tris(8-quinolinolato)aluminum (abbreviation: Alq<sub>3</sub>), Alq<sub>3</sub> doped with Nile Red that is a red luminescent dye, and Alq<sub>3</sub> are stacked in this order by a evaporation method or the like can be used.

[0057]

In addition, a structure in which, from the first electrode 101, NPB, NPB doped with perylene, bis(2-methyl-8-quinolinolato)-4-phenylphenolato-aluminum (abbreviation: BAq) doped with DCM1, BAq, and Alq<sub>3</sub> are stacked in this order by an evaporation method or the like can be used.

[0058]

Further, 2-(4-biphenyl)-5-(4-tert-butylphenyl)-1,3,4-oxadiazole (abbreviation: PBD) of 30 wt% is dispersed in poly(N-vinylcarbazole) (abbreviation: PVK) as an electron transporting agent, and then an appropriate amounts of 4 kinds of pigments (TPB, coumarin 6, DCM 1, and Nile Red) are dispersed to obtain white light emission.

[0059]

In addition, the second layer 112 is made to have a stacked structure, and the stacked structure is formed using materials that exhibit luminescent colors in relationship of complementary colors to each other, for example, a first layer and a second layer using luminescent materials for red and blue-green, whereby white light emission can be obtained.

[0060]

It is to be noted that materials for the light emitting layer can be appropriately selected besides the light emitting elements described above, which provide white light emission. For example, the second layer 112 may be formed from respective luminescent materials for red (R), green (G), and blue (B).

[0061]

In order to obtain red luminescence, 4-dicyanomethylene-2-isopropyl-6-[2-(1,1,7,7-tetramethyljulolidin-9-yl)ethenyl]-4H-pyran (abbreviation: DCJTl), 4-dicyanomethylene-2-methyl-6-[2-(1,1,7,7-tetramethyljulolidin-9-yl)ethenyl]-4H-pyran

n (abbreviation: DCJT),  
4-dicyanomethylene-2-tert-butyl-6-[2-(1,1,7,7-tetramethyljulolidin-9-yl)ethenyl]-4H-pyran (abbreviation: DCJTB), periflanthene, 2,5-dicyano-1,4-bis[2-(10-methoxy-1,1,7,7-tetramethyljulolidin-9-yl)ethenyl]benzene, 5 bis[2,3-bis(4-fluorophenyl)quinoxalinato]iridium(acetylacetonate) (abbreviation: Ir[Fdpq]<sub>2</sub>acac), or the like can be used. However, the luminescent material is not limited to these materials, and a material that produces luminescence with an emission spectrum peak from 600 nm to 700 nm can be used.

[0062]

10 In order to obtain green luminescence, N,N'-dimethylquinacridon (abbreviation: DMQd), coumarin 6, coumarin 545T, tris(8-quinolinolato)aluminum (abbreviation: Alq<sub>3</sub>), and the like can be used. However, the luminescent material is not limited to these materials, and a material that produces luminescence with an emission spectrum peak from 500 nm to 600 nm can be used.

15 [0063]

The triazine derivative according to the present invention can also function as a layer including a light emitting layer that produces blue luminescence. The triazine derivative according to the present invention can be specifically used as a host material for the light emitting layer that produces blue luminescence. Therefore, the light 20 emitting element according to the present invention has a layer including the triazine derivative according to the present invention and a luminescent material with an emission wavelength in the bandwidth from 400 nm to 500 nm between a pair of electrodes to produce blue luminescence. It is to be noted that the triazine derivative according to the present invention can be used for either a host or a dopant.

25 [0064]

Further, in order to obtain blue luminescence, 9,10-bis(2-naphthyl)-tert-butylanthracene (abbreviation: t-BuDNA), 9,9'-bianthryl, 9,10-diphenylanthracene (abbreviation: DPA), 9,10-bis(2-naphthyl)anthracene (abbreviation: DNA), bis(2-methyl-8-quinolinolato)-4-phenylphenolate-gallium 30 (abbreviation: BGaq), bis(2-methyl-8-quinolinolato)-4-phenylphenolate-aluminum (abbreviation: BALq), and the like can be used in addition to the layer containing the triazine derivative according to the present invention. However, the luminescent

material is not limited to these materials, and a material that produces luminescence with an emission spectrum peak from 400 nm to 500 nm can be used.

[0065]

When the second layer 112 is formed to have respective luminescent materials  
5 for red (R), green (G), and blue (B), a color filter or a color conversion layer may be additionally provided to adjust the peak of each of luminescence spectrum peak and the like. The color filter and the color conversion layer may be formed on the side where luminescence is extracted outside, that is, can be provided either on the substrate side where a thin film transistor is formed or on the opposed substrate thereto side.

10 [0066]

The second layer 112 can be manufactured by an evaporation method. In the case of forming a mixed layer, a co-evaporation method can be used. A co-evaporation method for forming the second layer 112 can be used by combining similar type and different type methods such as a co-evaporation method of  
15 resistance-heating evaporations, a co-evaporation method of electron beam evaporations, a co-evaporation method of resistance-heating evaporation and electron beam evaporation, deposition of resistance-heating evaporation and sputtering, and deposition of electron beam deposition and sputtering. Although the above example is applied to a layer including two kinds of materials, a layer including three or more kinds of  
20 materials can be formed by combining the similar type and the different type methods as described above.

[0067]

The third layer 113 is an electron generating layer. The triazine derivative according to the present invention can be applied to the third layer 113, namely, the  
25 electron generating layer. As the layer like this, for example, a layer containing an electron transporting substance and a substance that exhibits an electron donating property with respect to the electron transporting substance can be cited in addition to a layer containing the triazine derivative according to the present invention.

[0068]

30 It is to be noted that the electron transporting substance is a substance, an electron transporting property of which is higher than a hole transporting property. For example, metal complexes such as tris(8-quinolinolato)aluminum (abbreviation: Alq<sub>3</sub>),

tris(4-methyl-8-quinolinolato)aluminum (abbreviation:  $\text{Almq}_3$ ),  
 bis(10-hydroxybenzo[h]-quinolinato)beryllium (abbreviation:  $\text{BeBq}_2$ ),  
 bis(2-methyl-8-quinolinolato)-4-phenylphenolate-aluminum (abbreviation:  $\text{BAIq}$ ),  
 bis[2-(2-hydroxyphenyl)benzoxazolato]zinc (abbreviation:  $\text{Zn(BOX)}_2$ ), and  
 5 bis[2-(2-hydroxyphenyl)benzothiazolato]zinc (abbreviation:  $\text{Zn(BTZ)}_2$ ) can be used.  
 In addition, 2-(4-biphenyl)-5-(4-tert-butylphenyl)-1,3,4-oxadiazole (abbreviation:  
 PBD); 1,3-bis[5-(p-tert-butylphenyl)-1,3,4-oxadiazol-2-yl]benzene (abbreviation:  
 OXD-7); 3-(4-tert-butylphenyl)-4-phenyl-5-(4-biphenyl)-1,2,4-triazole (abbreviation:  
 TAZ); 3-(4-tert-butylphenyl)-4-(4-ethylphenyl)-5-(4-biphenyl)-1,2,4-triazole  
 10 (abbreviation: p-EtTAZ); bathophenanthroline (abbreviation: BPhen); bathocuproin  
 (abbreviation: BCP); 4,4'-bis(5-methyl-benzoxazol-2-yl)stilbene (abbreviation:  $\text{BzOs}$ );  
 and the like can be used. Further, the third layer 113 can be formed by using an n-type  
 semiconductor. However, the electron transporting substance is not limited to these.  
 [0069]

15 For a substance that exhibits an electron donating property with respect to the  
 electron transporting substance, a material selected from alkali metals and alkaline earth  
 metals, specifically, lithium (Li), calcium (Ca), sodium (Na), potassium (K), magnesium  
 (Mg), and the like can be used. Further, specific materials include oxides of the alkali  
 metals and alkaline earth metal mentioned above, a nitride of the alkali metal, a nitride  
 20 of the alkaline earth metal, and the like, specifically, lithium oxide ( $\text{Li}_2\text{O}$ ), calcium  
 oxide ( $\text{CaO}$ ), sodium oxide ( $\text{Na}_2\text{O}$ ), potassium oxide ( $\text{K}_2\text{O}$ ), magnesium oxide ( $\text{MgO}$ ),  
 lithium fluoride ( $\text{LiF}$ ), cesium fluoride ( $\text{CsF}$ ), calcium fluoride ( $\text{CaF}_2$ ), and the like.  
 However, the substance that exhibits the electron donating property with respect to the  
 electron transporting substance is not limited to these. It is preferable that the  
 25 substance that exhibits the electron donating property with respect to the electron  
 transporting substance be included so that a molar ratio with respect to that of the  
 electron transporting substance (= the substance that exhibits the electron donating  
 property with respect to the electron transporting substance / the electron transporting  
 substance) is 0.5 to 2.

30 [0070]

Alternatively, the third layer 113 may be a layer composed of a material such as  
 zinc oxide, zinc sulfide, zinc selenide, tin oxide or titanium oxide.

[0071]

When the triazine derivative according to the present invention is applied to the electron generating layer and a layer in which the triazine derivative and a metal oxide are mixed is formed, it is preferable that any one of lithium oxide ( $\text{Li}_2\text{O}$ ), calcium oxide (CaO), sodium oxide ( $\text{Na}_2\text{O}$ ), potassium oxide ( $\text{K}_2\text{O}$ ), magnesium oxide ( $\text{MgO}$ ),  
5 lithium fluoride ( $\text{LiF}$ ), cesium fluoride ( $\text{CsF}$ ), and calcium fluoride ( $\text{CaF}_2$ ) be used in the metal oxide. For example, in the case of using lithium oxide, it is believed that the triazine derivative functions as the electron transporting substance and the lithium oxide functions as the substance that exhibits the electron donating property with respect to  
10 the electron transporting substance.

[0072]

Such a third layer 103 can be manufactured by an evaporation method. In the case of forming a mixed layer, a co-evaporation method can be used. A co-evaporation method for forming the third layer 113 can be used by combining  
15 similar type and different type methods such as a co-evaporation method of resistance-heating evaporations, a co-evaporation method of electron beam evaporations, a co-evaporation method of resistance-heating evaporation and electron beam evaporation, deposition of resistance-heating evaporation and sputtering, and deposition of electron beam evaporation and sputtering. Although the above example is applied  
20 to a layer including two kinds of materials, a layer including three or more kinds of materials can be formed to combine the similar type and the different type methods as mentioned above.

[0073]

The first layer 111 to the third layer 113 can be formed by the same method as  
25 described above. Therefore, the layers can be formed continuously without being exposed to the atmosphere. Forming the first layer 111 to the third layer continuously without being exposed to the atmosphere in this way makes it possible to reduce mixing of impurities into an interface and the like.

[0074]

30 In the light emitting element described above, the difference between electron affinity of the electron transporting substance which is included in the third layer 113 and that of a substance which is included in the layer among the layers included in the

second layer 112, which is in contact with the third layer 113, is preferably made to be 2 eV or less, more preferably, 1.5 eV or less. When the third layer 113 comprises an n-type semiconductor, the difference between the work function of the n-type semiconductor and the electron affinity of the material which is included in the layer among the layers included in the second layer 112, which is in contact with the third layer 113, is preferably made to be 2 eV or less, more preferably, 1.5 eV or less. Therefore, by making a contact between the second layer 112 and the third layer 113, electrons can be easily injected into the second layer 112 from the third layer 113.

[0075]

It is to be noted that the present invention has a feature of a light emitting element including the triazine derivative between a pair of electrodes and is not limited to the structure of the light emitting element shown in FIG.1. For example, although the structure in which the electron transporting layer 124 is provided in contact with the third layer 113 is shown, there may be a case in which the electron transporting layer 124 is not provided. Then, the light emitting layer 123 in contact with the third layer 113 is provided. In this case, a material for dispersing the luminescent material is preferably used for the light emitting layer 123. It may well be that there is a case in which the hole transporting layer 122 is not provided.

[0076]

Further, a material that can emit light such as Alq<sub>3</sub> without being dispersed can be used for the light emitting layer 123. Since the material such as Alq<sub>3</sub> is a luminescent material that has an excellent carrier transporting property, a layer composed of only Alq<sub>3</sub> can function as a light emitting layer without dispersing Alq<sub>3</sub>. In this case, the light emitting layer 123 corresponds to the luminescent material itself.

[0077]

Further, in the second layer 112, a layer that functions as an electron injecting layer can be provided for making it easier to inject electrons into the second layer 112 from the third layer 113. In the second layer 112, similarly, a layer that functions as a hole injecting layer can be provided for making it easier to inject holes into the second layer 112 from the first layer 111.

[0078]

Next, electrodes will be described. Each of the first electrode 101 and the

second electrode 102 is formed by using a conductive material. Further, it is necessary that the electrode provided on the side where light from the light emitting layer is extracted outside have a light-transmitting property in addition to conductivity. The light-transmitting property can also be obtained by forming a quite thin film composed  
5 of a non-light-transmitting material.

[0079]

As a material for the first electrode 101, a light-transmitting material such as indium tin oxide (ITO), indium tin oxide containing silicon oxide (referred to as ITSO for convenience), or indium oxide containing zinc oxide at 2 % to 20 % can be used in  
10 addition to aluminum. Additionally, a metal material such as gold (Au), platinum (Pt), nickel (Ni), tungsten (W), chromium (Cr), molybdenum (Mo), iron (Fe), cobalt (Co), copper (Cu), or palladium (Pd) can be used. However, the material for the first electrode 101 is not limited to the above.

[0080]

15 When the non-light-transmitting material described above is used and the first electrode 101 needs to have a light-transmitting property, the material may be used to form a thin film.

[0081]

Further, for the first electrode 101, a single layer or a stacked layer of the metal  
20 material mentioned above can be used. Therefore, when a stacked layer is used for the first electrode 101, a structure in which the above material is formed to be thin and a light-transmitting material is stacked thereon may be used. As a matter of course, the first electrode 101 may be formed with the use of the thin material as a single layer. An auxiliary wiring can be provide in order to prevent the resistance from increasing by  
25 forming the first electrode 101 to be thin. Further, the resistance can be prevented from increasing by using a stacked layer in electrodes.

[0082]

As a material for the second electrode 102, a light-transmitting material such as indium tin oxide (ITO), indium tin oxide containing silicon oxide (refer to ITSO for convenience), or indium oxide containing zinc oxide at 2 % to 20 % can be used.  
30 Additionally, a metal material such as gold (Au), platinum (Pt), nickel (Ni), tungsten

(W), chromium (Cr), molybdenum (Mo), iron (Fe), cobalt (Co), copper (Cu), or palladium (Pd) can be used. However, the material of the second electrode 102 is not limited to the above.

[0083]

5           When the above material having the non-light-transmitting property is used and the first electrode 101 needs to have a transmitting property, the above material may be formed with a thin thickness.

[0084]

10           Further, for the second electrode 102, a single layer or a stacked layer of the metal material mentioned above can be used. Therefore, when a stacked layer is used for the first electrode 101, a structure in which the above material is formed to be thin and a light-transmitting material is stacked thereon may be used. As a matter of course, the first electrode 101 may be formed with the use of the thin material as a single layer. An auxiliary wiring can be provide in order to prevent the resistance from increasing by forming the second electrode 102 to be thin. Further, the resistance can be prevented from increasing by using a stacked layer.

[0085]

20           The first electrode 101 or the second electrode 102 can be formed by sputtering, an evaporation method, or the like. When an evaporation method is used, appropriately, the first electrode 101, the first layer 111 to the third layer 113, and the second electrode 102 can be formed continuously without being exposed to the atmosphere. Forming the light emitting element continuously without being exposed to the atmosphere makes it possible to reduce mixing of impurities into an interface and the like.

25           [0086]

(Embodiment 2)

          In the present embodiment, the structure of a light emitting element that is different from the light emitting element in the above embodiment will be described.

[0087]

30           As shown in FIG. 2, a light emitting element shown in the present embodiment has a first electrode 101 and a second electrode 102 which are opposed to each other, and has a first layer 111, a second layer 112, a third layer 113, and a fourth layer 128 are



stacked in this order from the first electrode 101, and a feature that the fourth layer 128 is provided. The fourth layer 128 can be formed from the similar material of the first layer 111, and the other structure is the similar to that of the above embodiment. Therefore, the description of the structure will be omitted.

5 [0088]

Providing the fourth layer 128 in this manner makes it possible to reduce damage in forming the second electrode 102.

[0089]

As the fourth layer 128, a layer in which at least one selected from vanadium oxide, molybdenum oxide, niobium oxide, rhenium oxide, tungsten oxide, ruthenium oxide, titanium oxide, chromium oxide, zirconium oxide, hafnium oxide, tantalum oxide, and the like is mixed. Further, nitrides or oxynitrides of these metals may be used. This is because by using these metal oxides and the like, it is not necessary to increase the driving voltage even when the fourth layer 128 is made thicker.

15 [0090]

By making the fourth layer 128 thicker, damage in forming the second electrode 102 can be expected to be further reduced.

[0091]

(Embodiment 3)

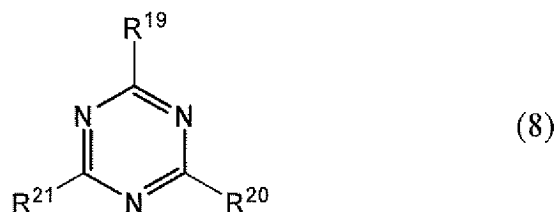
20 In the present embodiment, a triazine derivative will be described.

[0092]

A triazine derivative according to the present invention is represented by a general formula (8).

[0093]

25 [Chemical Formula 03]



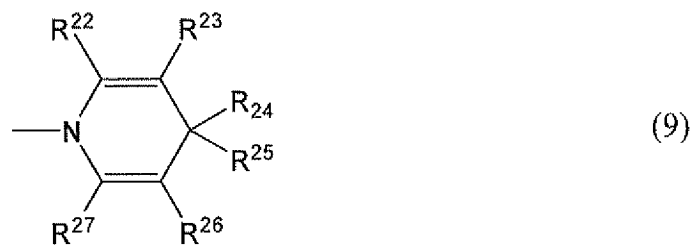
[0094]

In the general formula (8), R<sup>19</sup> to R<sup>21</sup> are individually independent and any one

of groups represented by formulas (9) to (15).

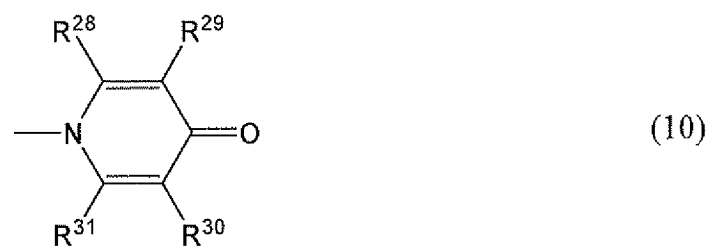
[0095]

[Chemical Formula 04]

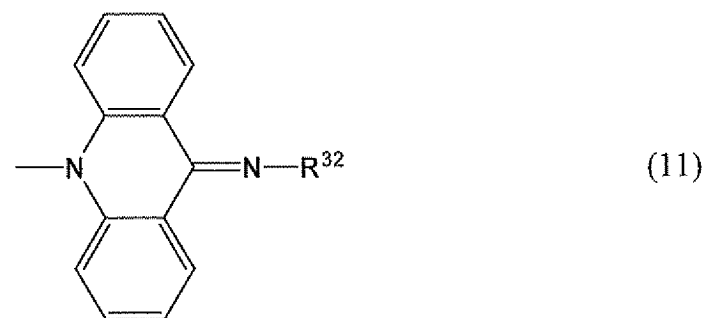


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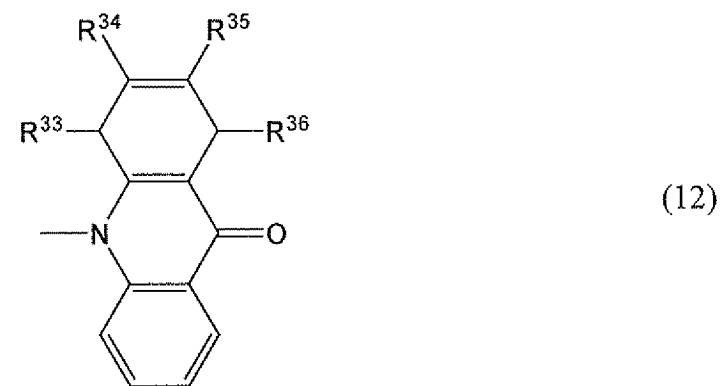
[Chemical Formula 05]



[Chemical Formula 06]

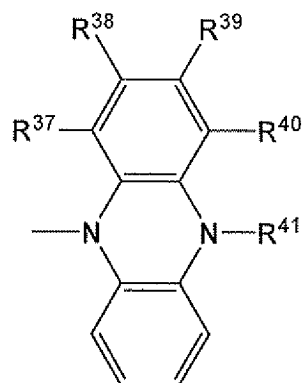


[Chemical Formula 07]



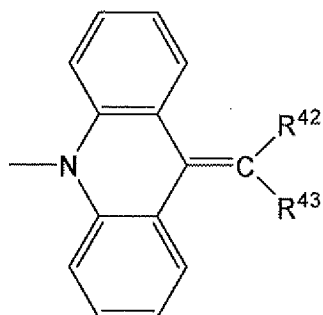
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[Chemical Formula 08]



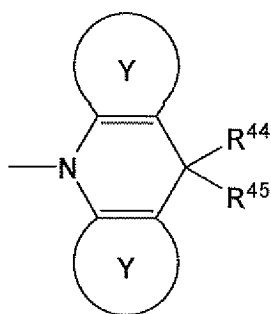
(13)

[Chemical Formula 09]



(14)

[Chemical Formula 10]



(15)

5

[0096]

In the group represented by the formula (9),  $R^{24}$  and  $R^{25}$  are individually independent, or bonded to form a ring. When  $R^{24}$  and  $R^{25}$  are independent,  $R^{24}$  and  $R^{25}$  are individually any one of hydrogen, an alkyl group having 1 to 6 carbon atoms, an aryl group having 6 to 30 carbon atoms (preferably, 6 to 14 carbon atoms), and a heteroaromatic group having 2 to 18 carbon atoms (preferably, 2 to 10 carbon atoms). It is to be noted that the alkyl group includes an aliphatic heteroaromatic group in the present invention. However, it is preferable to use a chain alkyl group because

handling is easy. The preferable number of carbon atoms in the aryl group and the heteroaromatic group is determined in consideration of a raw material and easiness of handling thereof.

[0097]

5 Further, it is preferable that the heteroaromatic group have a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring. Furthermore, the heteroaromatic group contains an atom which is any of nitrogen,  
10 oxygen, and sulfur.

[0098]

When  $R^{24}$  and  $R^{25}$  are bonded to form a ring, the ring is an alicycle having 3 to 10 carbon atoms (preferably, 6 carbon atoms). The preferable number of carbon atoms in the alicycle is determined in consideration of a raw material and easiness of handling  
15 thereof. When the number of carbon atoms in the alicycle is much increased, the melting point (Tg) of the compound may be greatly decreased, and it may be difficult in handling.

[0099]

$R^{22}$ ,  $R^{23}$ ,  $R^{26}$ , and  $R^{27}$  are individually independent, or  $R^{22}$  and  $R^{23}$ , and  $R^{26}$  and  
20  $R^{27}$  are individually bonded to form a ring. When  $R^{22}$ ,  $R^{23}$ ,  $R^{26}$ , and  $R^{27}$  are individually independent,  $R^{22}$ ,  $R^{23}$ ,  $R^{26}$ , and  $R^{27}$  are individually any one of hydrogen, an alkyl group having 1 to 6 carbon atoms, an alkoxy group having 1 to 6 carbon atoms, a halogen group, an acyl group having 1 to 6 carbon atoms, an alkoxycarbonyl group having 1 to 6 carbon atoms, a cyano group, an aryl group having 6 to 30 carbon atoms  
25 (preferably, 6 to 14 carbon atoms), and a heteroaromatic group having 2 to 18 carbon atoms (preferably, 2 to 10 carbon atoms). It is to be noted that the alkyl group includes an aliphatic heteroaromatic group in the present invention. However, it is preferable to use a chain alkyl group because handling is easy. The preferable number of carbon atoms in the aryl group and the heteroaromatic group is determined in consideration of a  
30 raw material and easiness of handling thereof.

[0100]

Further, it is preferable that the heteroaromatic group have a monocyclic

structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring. Furthermore, the heteroaromatic group contains an atom which is any of nitrogen,  
5 oxygen, and sulfur.

[0101]

When  $R^{22}$  and  $R^{23}$ ,  $R^{26}$  and  $R^{27}$  are individually bonded to form a ring, these rings are individually an alicycle having 3 to 10 carbon atoms (preferably, 6 carbon atoms). The preferable number of carbon atoms in the alicycle is determined in  
10 consideration of a raw material and easiness of handling thereof. When the number of carbon atoms in the alicycle is much increased, the melting point (Tg) of the compound may be greatly decreased, and it may be difficult in handling.

[0102]

In the group represented by the formula (10),  $R^{28}$  to  $R^{31}$  are individually  
15 independent, and any one of hydrogen, an alkyl group having 1 to 6 carbon atoms, an alkoxy group having 1 to 6 carbon atoms, a halogen group, an acyl group having 1 to 6 carbon atoms, an alkoxycarbonyl group having 1 to 6 carbon atoms, an aryl group having 6 to 30 carbon atoms (preferably, 6 to 14 carbon atoms), and a heteroaromatic group having 2 to 18 carbon atoms (preferably, 2 to 10 carbon atoms). It is to be  
20 noted that the alkyl group includes an aliphatic heterocyclic group in the present invention. However, it is preferable to use a chain alkyl group because handling is easy. The preferable number of carbon atoms in the aryl group and the heteroaromatic group is determined in consideration of a raw material and easiness of handling thereof.

[0103]

25 Further, it is preferable that the heteroaromatic group have a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring. Furthermore, the heteroaromatic group contains an atom which is any of nitrogen,  
30 oxygen, and sulfur.

[0104]

In the group represented by the formula (11),  $R^{32}$  represents any of an aryl

group having 6 to 30 carbon atoms (preferably, 6 to 14 carbon atoms) and a heteroaromatic group having 2 to 18 carbon atoms (preferably, 2 to 10 carbon atoms). The preferable number of carbon atoms in the aryl group and the heteroaromatic group is determined in consideration of a raw material and easiness of handling thereof. The  
5 aryl group may have a substituent such as an alkyl group having 1 to 6 carbon atoms, an alkoxy group having 1 to 6 carbon atoms, an acyl group having 1 to 6 carbon atoms, an alkoxycarbonyl group having 1 to 6 carbon atoms, or a halogen group, or may be unsubstituted. It is to be noted that the alkyl group includes an aliphatic heteroaromatic group in the present invention. However, it is preferable to use a chain  
10 alkyl group because handling is easy.

[0105]

Further, it is preferable that the heteroaromatic group have a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or  
15 a polycyclic structure containing a 5-membered ring and a 6-membered ring. Furthermore, the heteroaromatic group contains an atom which is any of nitrogen, oxygen, and sulfur.

[0106]

In addition, the aryl group and the heteroaromatic group may be individually  
20 condensed with another aromatic ring and another heterocyclic.

[0107]

In the group represented by the formula (12),  $R^{33}$  to  $R^{36}$  may be individually independent and may be any one of hydrogen, an alkyl group having 1 to 6 carbon atoms, an alkoxy group having 1 to 6 carbon atoms, an acyl group having 1 to 6 carbon  
25 atoms, an alkoxycarbonyl group having 1 to 6 carbon atoms, and a halogen group. It is to be noted that the alkyl group includes an aliphatic heteroaromatic group in the present invention. However, it is preferable to use a chain alkyl group because handling is easy.  $R^{33}$  and  $R^{34}$ ,  $R^{34}$  and  $R^{35}$ , or  $R^{35}$  and  $R^{36}$ , each of which are adjacent to each other, may be bonded to form an aromatic ring. The aromatic ring may include an oxo group  
30 or the like.

[0108]

In the group represented by the formula (13),  $R^{36}$  to  $R^{39}$  are individually

independent, or bonded to form a ring. When  $R^{36}$  to  $R^{39}$  are individually independent,  $R^{36}$  to  $R^{39}$  are hydrogen. When  $R^{37}$  and  $R^{38}$ , and  $R^{39}$  and  $R^{40}$  are individually bonded to form a ring, the ring is an aromatic ring. It is to be noted that the bond of  $R^{37}$  and  $R^{38}$  and the bond of  $R^{39}$  and  $R^{40}$  are individually independent.

5 [0109]

$R^{41}$  is any one of an alkyl group having 1 to 6 carbon atoms, an aryl group having 6 to 30 carbon atoms (preferably, 6 to 14 carbon atoms), and a heteroaromatic group having 2 to 18 carbon atoms (preferably, 2 to 10 carbon atoms). It is to be noted that the alkyl group includes an aliphatic heteroaromatic group in the present  
10 invention. However, it is preferable to use a chain alkyl group because handling is easy. The preferable number of carbon atoms in the aryl group and the heteroaromatic group is determined in consideration of a raw material and easiness of handling thereof. The aryl group may have a substituent such as a dialkylamino group, or may be unsubstituted.

15 [0110]

It is preferable that the heteroaromatic group have a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring. Furthermore, the  
20 heteroaromatic group contains an atom which is any of nitrogen, oxygen, and sulfur.

[0111]

In the group represented by the formula (14),  $R^{42}$  and  $R^{43}$  are individually independent, and be hydrogen, an aryl group having 6 to 30 carbon atoms (preferably, 6 to 14 carbon atoms), a heteroaromatic group having 2 to 18 carbon atoms (preferably, 2  
25 to 10 carbon atoms), or a cyano group. The preferable number of carbon atoms in the aryl group and the heteroaromatic group is determined in consideration of a raw material and easiness of handling thereof. The aryl group may have a substituent such as an alkyl group having 1 to 6 carbon atoms, an aryl group having 6 to 30 carbon atoms (preferably, 6 to 14 carbon atoms), or a halogen group, or may be unsubstituted. It is  
30 to be noted that the alkyl group includes an aliphatic heteroaromatic group in the present invention. However, it is preferable to use a chain alkyl group because handling is easy.

[0112]

It is preferable that the heteroaromatic group have a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring. Furthermore, the heteroaromatic group contains an atom which is any of nitrogen, oxygen, and sulfur.

[0113]

In the group represented by the formula (15), Y is an aromatic group, a heterocyclic, or an alicycle. It is to be noted that the aromatic group may have a substituent such as an oxo group, or may be unsubstituted. Further, it is preferable that the heterocyclic have a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring. Furthermore, the heterocyclic is preferable to contain an atom which is any of nitrogen, oxygen, and sulfur.  $R^{44}$  and  $R^{45}$  are individually independent, or bonded to form a ring. When  $R^{44}$  and  $R^{45}$  are independent,  $R^{44}$  and  $R^{45}$  are individually any one of hydrogen, an aryl group having 6 to 30 carbon atoms (preferably, 6 to 14 carbon atoms), a heteroaromatic group having 2 to 18 (preferably, 2 to 10 carbon atoms), and an alkyl group having 1 to 6 carbon atoms. It is to be noted that the alkyl group includes an aliphatic heteroaromatic group in the present invention. However, it is preferable to use a chain alkyl group because handling is easy. The preferable number of carbon atoms in the aryl group and the heteroaromatic group is determined in consideration of a raw material and easiness of handling thereof.

[0114]

It is preferable that the heteroaromatic group have a monocyclic structure of a 5-membered ring, a monocyclic structure of a 6-membered ring, a polycyclic structure containing any one of a 5-membered ring and a 6-membered ring, or a polycyclic structure containing a 5-membered ring and a 6-membered ring. Furthermore, the heteroaromatic group contains an atom which is any of nitrogen, oxygen, and sulfur.

[0115]

When  $R^{44}$  and  $R^{45}$  are bonded to form a ring, the ring is an alicycle having 3 to



10 carbon atoms (preferably, 6 carbon atoms). The preferable number of carbon atoms in the alicycle is determined in consideration of a raw material and easiness of handling thereof. When the number of carbon atoms in the alicycle is much increased, the melting point (T<sub>g</sub>) of the compound may be greatly decreased, and it may be difficult in

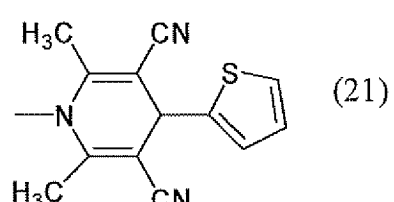
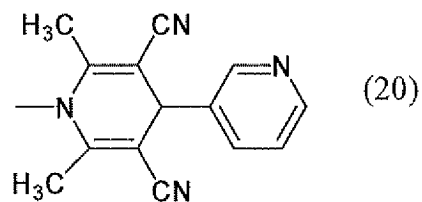
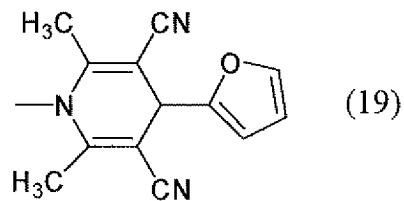
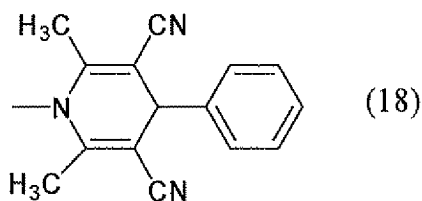
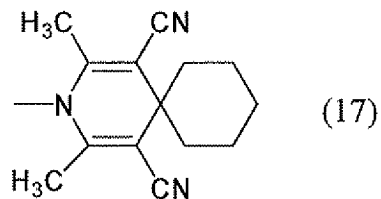
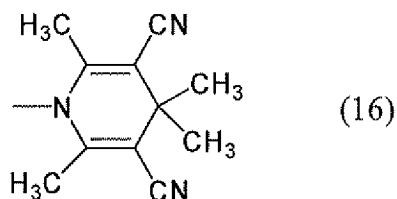
5 handling.

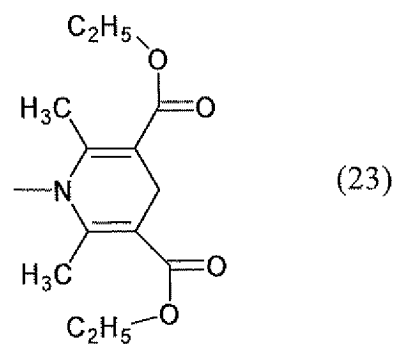
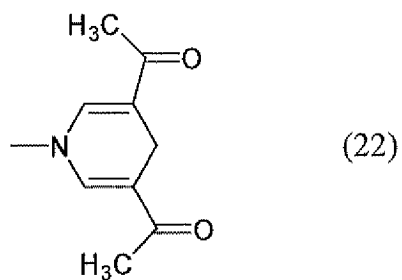
[0116]

Specific examples of the groups represented by the formulas (9) to (15) are represented by structural formulas (16) to (65).

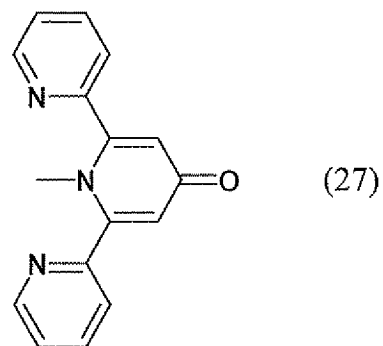
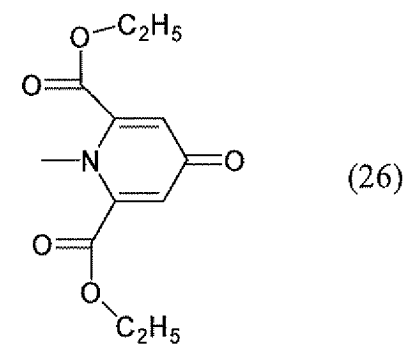
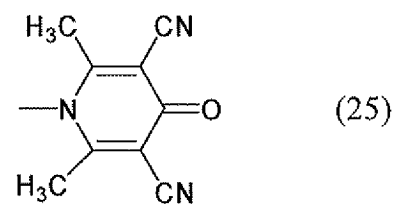
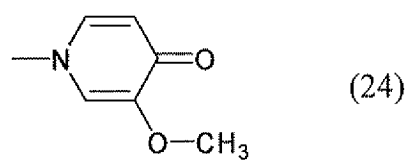
[0117]

10 [Chemical Formula 11]



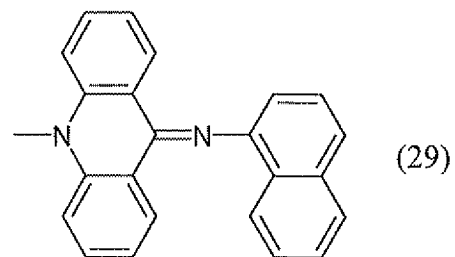
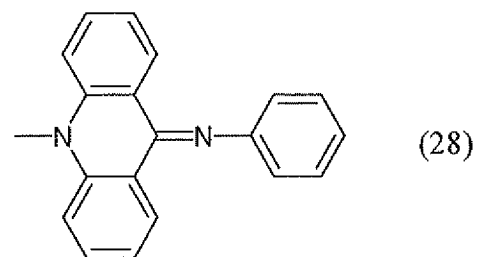


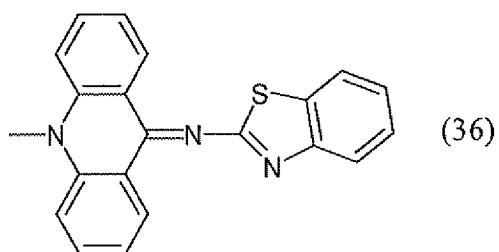
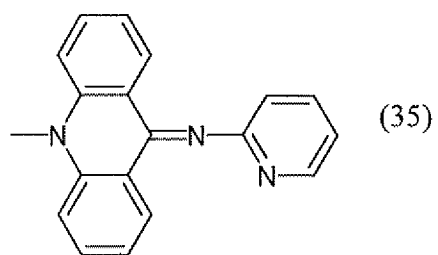
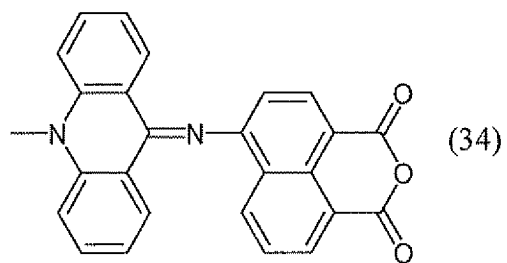
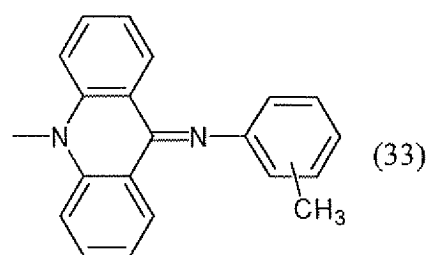
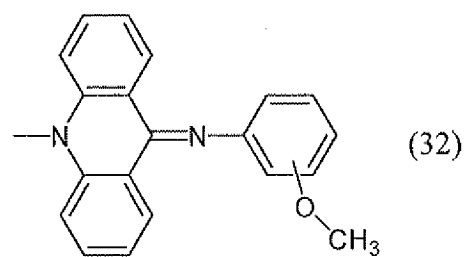
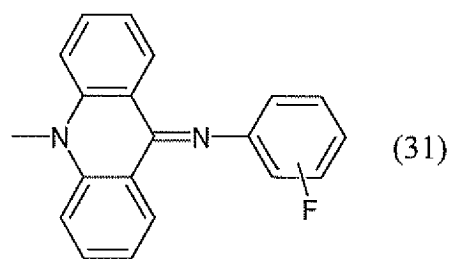
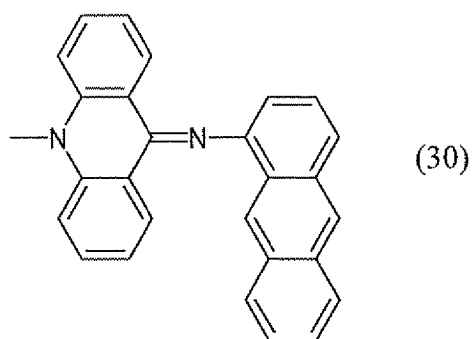
[Chemical Formula 12]

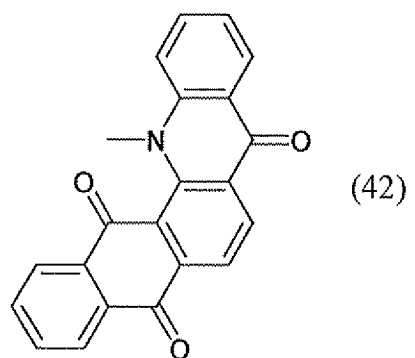
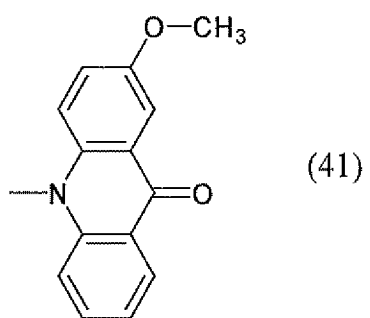
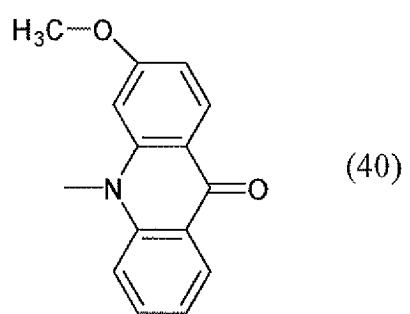
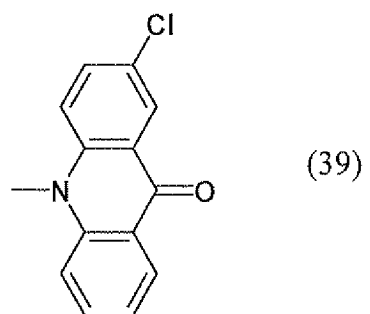
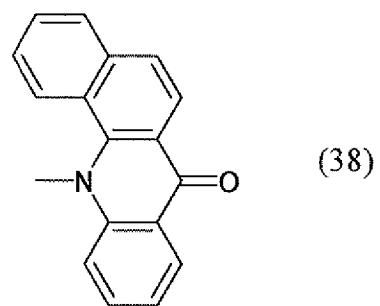
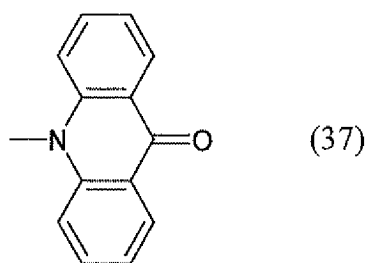


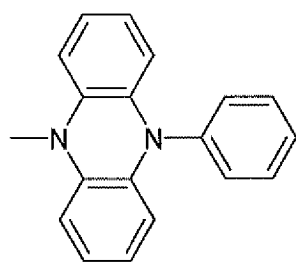
5

[Chemical Formula 13]

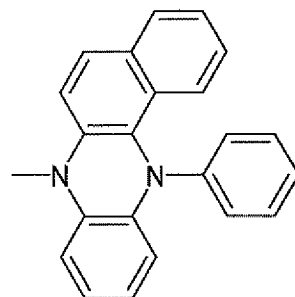




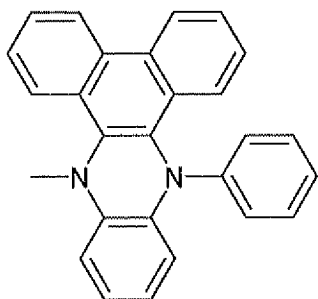




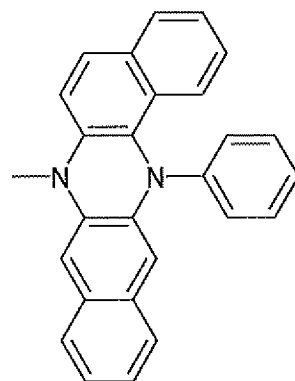
(43)



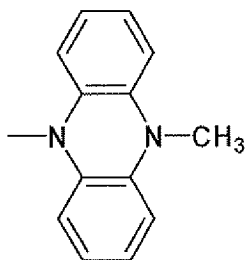
(44)



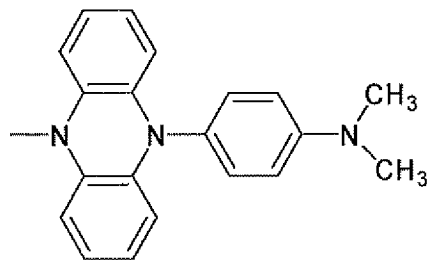
(45)



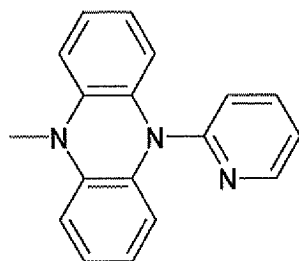
(46)



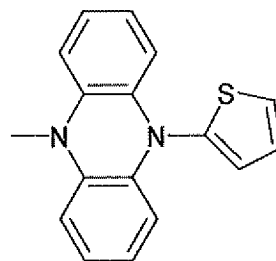
(47)



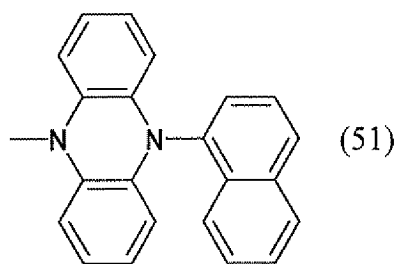
(48)



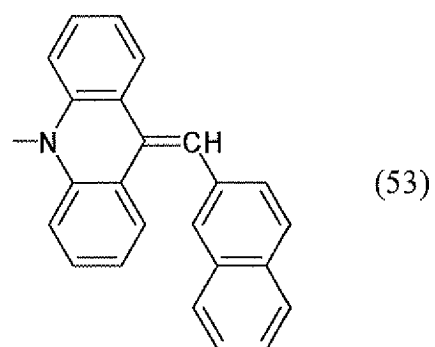
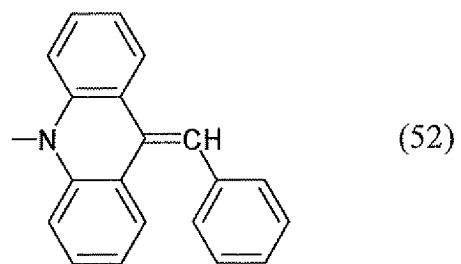
(49)



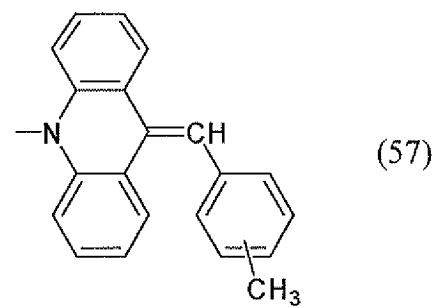
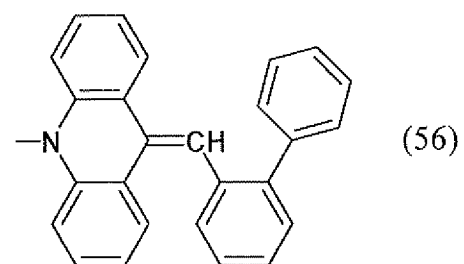
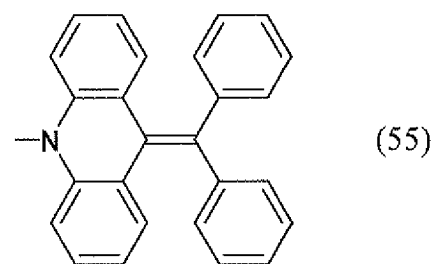
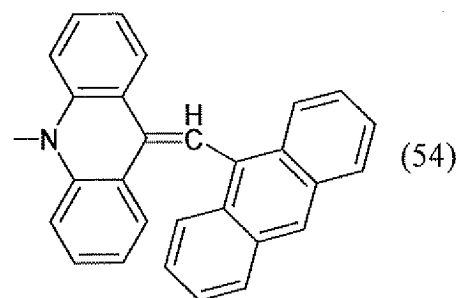
(50)



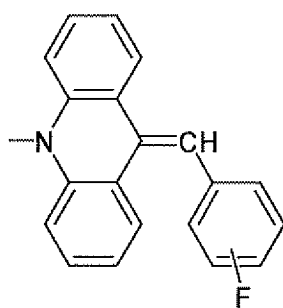
[Chemical Formula 16]



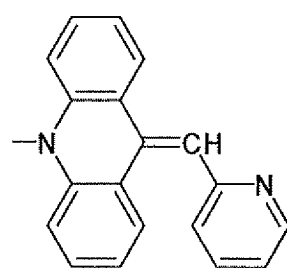
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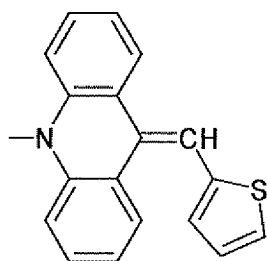
10



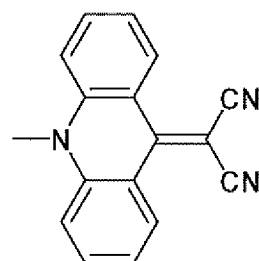
(58)



(59)



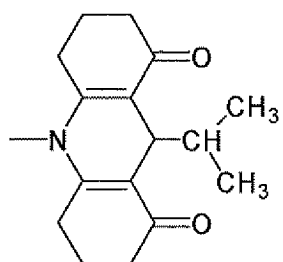
(60)



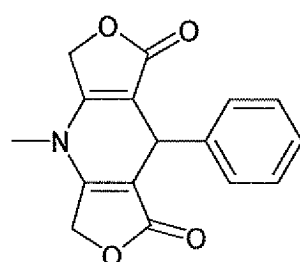
(61)

5

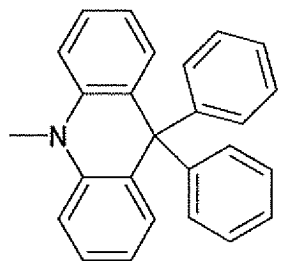
[Chemical Formula 17]



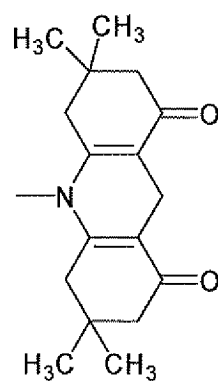
(62)



(63)



(64)



(65)

10

[0118]

The above-described triazine derivative according to the present invention can be used as a material for manufacturing a light emitting element. Thus, according to the present invention, a novel material for manufacturing a light emitting element can be obtained.

5 [0119]

The present embodiment can be freely combined with the above embodiments. For example, a light emitting element that has a layer in which the triazine derivative according to the present invention and a metal oxide are mixed can be formed by a co-evaporation method.

10 [0120]

(Embodiment 4)

In the present embodiment, a structure of a display device having the light emitting element described above will be described.

[0121]

15 In FIG. 3, a panel in which driver circuits such as a signal line driver circuit 302 and a scanning line driver circuit 303 are provided around a pixel portion 300 is shown.

[0122]

The scanning line driver circuit 303 has circuits functioning as a shift register 311, a level shifter 312, and a buffer 313. Signals such as a gate start pulse (GSP), a gate clock signal (GCK), and the like are inputted into the shift register 311. It is to be noted that a scanning line driver circuit according to the present invention is not limited to these.

[0123]

25 Further, the signal line driver circuit 302 has circuits functioning as a shift register 321, a first latch 313, a second latch 323, a level shifter 324, and a buffer 325. Signals such as a start pulse (SSP) and the like, data (DATA) such as a video signal and the like, and a latch (LAT) signal and the like are inputted into the shift register 321, the first latch 322, and the second latch 323, respectively. It is to be noted that the signal line driver circuit according to the present invention is not limited to these.

30 [0124]

The pixel portion 300 has a plurality of pixels, and each of the pixels is provided with the light emitting element as described above. A semiconductor element



for controlling current supply to the light emitting element is connected to each of the light emitting elements. A cross section of the pixel having the light emitting element will be described in the following embodiment. It is to be noted that the pixel portion according to the present invention is not limited to this, and may have a passive type structure.

[0125]

The signal line driver circuit 302, the scanning line driver circuit 303, and the pixel portion 300 can be formed using a semiconductor element provided over the same substrate. For example, a thin film transistor provided over a glass substrate can be used. Further, the signal line driver circuit 302 or the scanning line driver circuit 303 can be implemented over a glass substrate by using an IC chip.

[0126]

The present embodiment can be freely combined with any of the above embodiments.

[0127]

(Embodiment 5)

In the present embodiment, a cross section of a pixel having a light emitting element will be described.

[0128]

FIGS. 4A to 4C are cross-sectional views in each of which a p-channel thin film transistor (TFT) as a semiconductor element for controlling current supply to a light emitting element is used, and the case in which a first electrode functions as an anode and a second electrode functions as a cathode in the light emitting element will be described.

[0129]

FIG. 4A is a cross-sectional view of a pixel where a TFT 601 is a p-channel TFT and light emitted from a light emitting element 603 is extracted from a first electrode 101 side. In FIG. 4A, the TFT 601 provided over a substrate 600 has a semiconductor film, a gate electrode that is provided over the semiconductor film with an insulating film interposed therebetween, and a wiring connected to an impurity region formed in the semiconductor film. Further, the wiring of the TFT 601 is electrically connected to the first electrode 101 in the light emitting element 603.

[0130]

The TFT 601 is covered with an interlayer insulating film 608, and a partition 609 having an opening is formed on the interlayer insulating film 608. In the opening of the partition 609, the first electrode 101 is partially exposed, and the first electrode 101, an electroluminescent layer 605, and a second electrode 102 are stacked in this order in the opening. It is to be noted that the electroluminescent layer 605 in the present embodiment indicates the first layer 111 to the third layer 113, and additionally the fourth layer 128 of the embodiment described above. In other words, the electroluminescent layer 605 indicates the layers between the first electrode 101 and the second electrode 102.

[0131]

The interlayer insulating film 608 can be formed using an organic resin film, an inorganic insulating film, or an insulating film containing a Si-O-Si bond formed using a siloxane based material as a starting material (hereinafter, referred to as a "siloxane insulating film"). The siloxane insulating film contains hydrogen for a substituent, and in addition, at least one of fluorine, an alkyl group, and aromatic hydrocarbon can be contained. The interlayer insulating film 608 may also be formed using a material called low dielectric constant material (low-k material). The interlayer insulating film 608 may be either a single layer or a stacked layer.

[0132]

The partition 609 can be formed using an organic resin film, an inorganic insulating film, or a siloxane insulating film. In the case of using an organic resin film, for example, acrylic, polyimide, or polyamide can be used. In the case of using an inorganic insulating film, silicon oxide, silicon nitride oxide, or the like can be used. The partition 609 is formed using a photosensitive organic resin film and has an opening on the first electrode 101, such that the side face thereof has a slope with a continuous curvature, thereby preventing the first electrode 101 and the second electrode 102 from being connected to each other. Further, the partition 609 may be either a single layer or a stacked layer.

[0133]

In FIG. 4A, in order to extract light to the first electrode 101 side, the first electrode 101 is formed using a material or to have film a thickness enough to transmit

light. Further, the first electrode 101 is formed using a material that is suitable for being used as an anode. Moreover, in addition to the light-transmitting material mentioned above, the first electrode 101 may be formed using, for example, a single-layer film composed of one or more materials of TiN, ZrN, Ti, W, Ni, Pt, Cr, Ag, Al and the like, a stacked layer of titanium nitride and a film containing aluminum as a main component, a three-layer structure of a titanium nitride film, a film containing aluminum as a main component and a titanium nitride film, or the like. However, when a material except for the light-transmitting material is used, the first electrode 101 is formed with a thickness enough to transmit light (preferably, about 5 nm to 30 nm) as described in the above embodiment.

[0134]

The second electrode 102 is formed using a material that reflects or blocks light and with a thickness enough to reflect or block light. Further, the second electrode 102 is formed using a material that is suitable for being used as a cathode. That is, a metal, an alloy, an electrically conductive compound having a low work function, or a mixture thereof can be used. Specifically, an alkali metal such as Li or Cs, an alkaline earth metal such as Mg, Ca or Sr, an alloy containing such metals (Mg : Ag, Al : Li, Mg : In, or the like), a compound of such metals (CaF<sub>2</sub> or CaN), or a rare-earth metal such as Yb and Er can be used.

[0135]

The electroluminescent layer 605 is composed of a signal layer or a plurality of layers. Although the embodiments described above show the drawings (refer to FIGS. 1 and 2) in which the interface between the layers is clear, it is not always necessary to be clear. The materials forming the respective layers may be partially mixed to make the interface unclear.

[0136]

In the case of the pixel shown in FIG. 4A, light emitted from the light emitting element 603 can be extracted from the first electrode 101 side as indicated by a hollow arrow.

[0137]

FIG. 4B is a cross-sectional view of a pixel where a TFT 601 is a p-channel TFT and light emitted from a light emitting element 603 is extracted from a second

electrode 102 side. In FIG. 4B, a first electrode 101 of the light emitting element 603 is electrically connected to the TFT 601. Further, on the first electrode 101, an electroluminescent layer 605 and the second electrode 102 are stacked in this order.

[0138]

5           The first electrode 101 is formed using a material that reflects or blocks light and to have a film thickness enough to reflect or block light. The first electrode 101 is formed using a material that is suitable for being used as an anode. For example, the first electrode 101 may be formed from a single-layer film composed of one or more materials of TiN, ZrN, Ti, W, Ni, Pt, Cr, Ag, Al and the like, a stacked layer of titanium  
10   nitride and a film containing aluminum as a main component, a three-layer structure of a titanium nitride film, a film containing aluminum as its main component, and a titanium nitride film, or the like.

[0139]

          The second electrode 102 is formed using a light-transmitting material or to  
15   have a film thickness enough to transmit light. Further, the second electrode 102 can be formed using a metal, an alloy, an electrically conductive compound each having a low work function or a mixture thereof. Specifically, an alkali metal such as Li or Cs, an alkaline earth metal such as Mg, Ca or Sr, an alloy containing such metals (Mg : Ag, Al : Li, Mg : In, or the like), and a compound of such metals (CaF<sub>2</sub> or CaN), or a  
20   rare-earth metal such as Yb and Er can be used. Then, the second electrode 102 is formed to have a thickness enough to transmit light (preferably, about 5 nm to 30 nm). It is to be noted that a light transmitting conductive oxide material such as indium tin oxide (ITO), zinc oxide (ZnO), indium zinc oxide (IZO), and zinc oxide doped with gallium (GZO) can also be used. Alternatively, ITO, indium tin oxide containing  
25   silicon oxide (ITSO), or indium oxide containing silicon oxide with which zinc oxide (ZnO) at 2 % to 20 % is mixed may be used.

[0140]

          The electroluminescent layer 605 can be formed similarly to the electroluminescent layer 605 in FIG. 4A.

30   [0141]

          In the case of the pixel shown in FIG. 4B, light emitted from the light emitting element 603 can be extracted from the second electrode 102 side as indicated by a

hollow arrow.

[0142]

FIG. 4C is a cross-sectional view of a pixel where a TFT 601 is a p-channel TFT and light emitted from the light emitting element 603 is extracted from both a first electrode 101 side and the second electrode 102 side. In FIG. 4C, the first electrode 101 in the light emitting element 603 is electrically connected to the TFT 601. In addition, over the first electrode 101, an electroluminescent layer 605 and the second electrode 102 are stacked in this order.

[0143]

The first electrode 101 can be formed similarly to the first electrode 101 shown in FIG. 4A. The second electrode 102 can be formed similarly to the second electrode 102 shown in FIG. 4B. The electroluminescent layer 605 can be formed similarly to the electroluminescent layer 605 shown in FIG. 4A.

[0144]

In the case of the pixel shown in FIG. 4C, light emitted from the light emitting element 603 can be extracted from both the first electrode 101 side and the second electrode 102 side as indicated by hollow arrows.

[0145]

It is to be noted that the pixel structure according to the present invention is not limited to this. For example, an n-channel TFT can be used for the semiconductor element for controlling current to the light emitting element 603. In this case, it is preferable that the first electrode 101 function as a cathode and the second electrode 102 function as an anode.

[0146]

Further, the connecting structure of the first electrode 101 and a wiring of the TFT 601 is not limited to FIGS. 4A to 4C. For example, the wiring in the TFT 601 may be formed after forming the first electrode 101. Furthermore, the first electrode 101 and the wiring of the TFT 601 can be formed at the same time.

[0147]

The present embodiment can be freely combined with the above embodiments.

[0148]

(Embodiment 6)

In the present embodiment, a cross-sectional structure of a panel for performing full color display, in which a color filter, a color conversion layer, and the like are provided will be described.

[0149]

5           As shown in FIG. 5, a pixel exhibiting red luminescence (R), a pixel exhibiting green luminescence (G), and a pixel exhibiting blue luminescence (B) can be formed in accordance with the pixel structure shown in the embodiment described above in order to perform full color display. It is to be noted that semiconductor elements of the pixels are denoted by 601R, 601G, and 601B, and electroluminescent layers thereof are  
10          denoted by 605R, 605G, and 605B in FIG.5.

[0150]

Next, sealing is performed with the use of an opposed substrate 610. Then, a space is formed between the opposed substrate 601 and a substrate 600. The space can be filled with an inert gas such as nitrogen or a resin. Accordingly, penetration of  
15          oxygen and moisture into the electroluminescent layers can be prevented. In addition, penetration of oxygen and moisture may be prevented by providing a drying agent appropriately. Further, a spacer for keeping the space between the opposed substrate 601 and the substrate 600 may be arranged, and the spacer may have a function as a  
drying agent.

20          [0151]

On the opposed substrate 610, 607R, 607G, and 607B as color filters or color conversion layers are respectively provided in regions opposed to the electroluminescent layers 605R, 605G, and 605B. Further, in regions opposed to the TFTs 601R, 601G, and 601B, resins 611 that function as a black matrix is provided.

25          [0152]

In this way, a light emitting device for extracting light from the opposed substrate 610 side can be formed. Luminescence can be extracted through the color filters or the like. Therefore, widths of luminescence spectra for RGB can be controlled, and a light emitting device that performs clear display can be provided.

30          [0153]

Although materials exhibiting luminescence for RGB are used for the electroluminescent layers in the present embodiment, materials are not limited to these.

For example, the above-described material exhibiting white luminescence may be used to perform full color display.

[0154]

FIG. 6 is a cross-sectional structure of a panel performing full color display in which a color filter, a color conversion layer and the like are provided on a substrate 600 side. The other structures are the same as those in FIG. 5, and the description thereof will be omitted.

[0155]

In the case of the cross-sectional structure of the panel shown in FIG. 6, a light emitting device for extracting light from the substrate 600 side can be formed.

[0156]

Similarly, when a light emitting element for extracting light from both the substrate 600 side and the opposed substrate 610 side is formed as shown in FIG. 4C, a color filter and the like may be provided on the substrate 600 side and the opposed substrate 610 side.

[0157]

In this way, the present embodiment can be freely combined with any of the above embodiments.

[0158]

(Embodiment 7)

In the present embodiment, a pixel circuit used for the display device described above will be described.

[0159]

FIG. 7A shows an example of an equivalent circuit diagram of a pixel, which includes a signal line 6114, a power supply line 6115, a scanning line 6116, and at an intersecting portion thereof, a light emitting element 603, transistors 6110 and 6111, and a capacitor 6112. For the light emitting element 603, the structure shown in the embodiment described above is used. A video signal is inputted into the signal line 6114 by a signal line driver circuit. The transistor 6110 can control supply of the video signal to a gate of the transistor 6111 in accordance with a selection signal to be inputted into the scanning line 6116. The transistor 6111 is a driving transistor that can control supply of current to the light emitting element 603 in accordance with the potential of

the video signal. The capacitor 6112 can hold voltage between gate and source of the transistor 6111. It is to be noted that although the capacitor 6112 is illustrated in FIG. 7A, it is not required to be provided if the gate capacitance of the transistor 6111 or the other parasitic capacitance is enough.

5 [0160]

FIG. 7B is an equivalent circuit diagram of a pixel where a transistor 6118 and a scanning line 6119 are additionally provided to the pixel shown in FIG. 7A. By the transistor 6118, potential of the gate and the source of the transistor 6111 can be equal to each other so that the state in which no current flows into the light emitting element 603 is forcibly made. Therefore, each subframe period can be set to be shorter than a period for inputting video signals into all pixels. Further, depending on the driving method, the state in which no current flows into the light emitting element 603 can be forcibly made even in a pixel shown in FIG. 7A.

[0161]

15 FIG. 7C is an equivalent circuit diagram of a pixel where a transistor 6125 and a wiring 6126 are additionally provided to the pixel shown in FIG. 7B. Gate potential of the transistor 6125 is fixed by the wiring 6126. In addition, the transistors 6111 and 6125 are connected in series between the power supply line 6115 and the light emitting element 603. Therefore, in FIG. 7C, the transistor 6125 can control the amount of current supplied to the light emitting element 603 whereas the transistor 6111 can control whether the current is supplied or not to the light emitting element 603.

20 [0162]

It is to be noted that a pixel circuit according to the present invention is not limited to the structure shown in the present embodiment, and an analog gradation can be used besides a digital gradation. The present embodiment can be freely combined with the above embodiments.

25 [0163]

(Embodiment 8)

An electronic device that is provided with a light emitting element according to the present invention includes: a television set (simply referred to as a TV, or a television receiver), a digital camera, a digital video camera, a mobile phone set (simply referred to as a cellular phone set, or a cellular phone), a portable information terminal



such as PDA, a portable game machine, a monitor for a computer, a computer, a sound reproducing device such as a car audio set, an image reproducing device provided with a recording medium such as a home game machine, and the like. Specific examples thereof will be described with reference to FIGS. 8A to 8F.

5 [0164]

A portable information terminal device shown in FIG. 8A includes a main body 9201, a display portion 9202, and the like. The light emitting device according to the present invention can be applied to the display portion 9202. Accordingly, it is possible to provide a portable information terminal device in which a light emitting  
10 element can be made thicker and lower power consumption can be achieved without increasing the driving voltage.

[0165]

A digital video camera shown in FIG. 8B includes a display portion 9701, a display portion 9702, and the like. The light emitting device according to the present  
15 invention can be applied to the display portion 9701. Accordingly, it is possible to provide a digital video camera in which a light emitting element can be made thicker and lower power consumption can be achieved without increasing the driving voltage.

[0166]

A cellular phone shown in FIG. 8C includes a main body 9101, a display  
20 portion 9102, and the like. The light emitting device according to the present invention can be applied to the display portion 9102. Accordingly, it is possible to provide a cellular phone in which a light emitting element can be made thicker and lower power consumption can be achieved without increasing the driving voltage.

[0167]

25 A portable television set shown in FIG. 8D includes a main body 9301, a display portion 9302, and the like. The light emitting device according to the present invention can be applied to the display portion 9302. Accordingly, it is possible to provide a portable television set in which a light emitting element can be made thicker and lower power consumption can be achieved without increasing the driving voltage.  
30 Further, the light emitting device according to the present invention can be applied to various types of television sets such as a small-sized television incorporated in a portable terminal such as a cellular phone machine, a medium-sized television which is

portable, and a large-sized television (for example, 40 inches in size or more).

[0168]

A portable computer shown in FIG. 8E includes a main body 9401, a display portion 9402, and the like. The light emitting device according to the present invention can be applied to the display portion 9402. Accordingly, it is possible to provide a portable computer in which a light emitting element can be made thicker and lower power consumption can be achieved without increasing the driving voltage.

[0169]

A television set shown in FIG. 8F includes a main body 9501, a display portion 9502, and the like. The light emitting device according to the present invention can be applied to the display portion 9502. Accordingly, it is possible to provide a television set in which a light emitting element can be made thicker and lower power consumption can be achieved without increasing the driving voltage.

[0170]

Therefore, according to the present invention, it is possible to provide an electronic device in which a light emitting element can be made thicker and lower power consumption can be achieved without increasing the driving voltage.

[Example]

[0171]

(Synthesis Example 1)

A synthesis method of 1,3,5-tris(acridon-N-yl)triazine is described.

[0172]

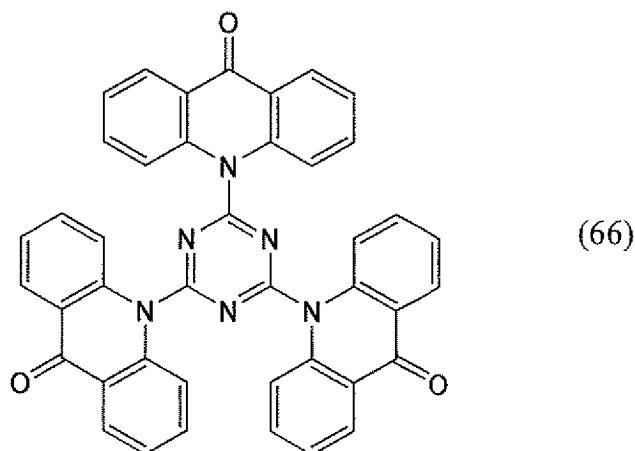
Acridone (10.0 g, 54.6 mmol) was added gradually into a dried THF (tetrahydrofuran) suspension (200 mL) of sodium hydride (60 % in oil, 2.4g, 60 mmol) under cooling with ice. The suspension was stirred at room temperature for 30 minutes, and a dried THF solution (50 mL) of cyanuric chloride (2.50 g, 13.8 mmol) was dropped into the solution. After stirring at room temperature for 12 hours, reflux for 6 hours was performed by heating. Then, approximately 100 mL of ethanol was added into a reaction mixture, and a precipitated solid was filtered. The obtained solid was dissolved in warm chloroform, and celite filtration was performed. The filtrate was concentrated to perform recrystallization, and a pale yellow compound was obtained at a yield of 77 %.

[0173]

Measurement of the obtained compound by NMR (nuclear magnetic resonance) could confirm that the obtained compound was 1,3,5-tris(acridon-N-yl)triazine represented by a structural formula (66).

5 [0174]

[Chemical Formula 18]



[0175]

10 The NMR (nuclear magnetic resonance) spectrum data are shown as follows.

$^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  7.37-7.51 (m, 12H), 7.67 (d, 6H,  $J = 8.4\text{Hz}$ ), 8.35 (dd, 6H,  $J = 1.8, 7.8\text{Hz}$ ).  $^{13}\text{C}$  NMR (75.5 MHz,  $\text{CDCl}_3$ )  $\delta$  121.8, 124.9, 126.1, 127.1, 132.6, 136.4, 140.5, 179.7.

[0176]

15 Further, the obtained compound was measured with a melting point apparatus (manufactured by As One Corporation, ATM-01) to find that the melting point was 300 °C or more.

[0177]

20 In addition, the obtained compound was deposited by an evaporation method. Then, when an ionization potential of the compound in a thin film state was measured with a photoelectron spectrometer (manufactured by Riken Keiki Co., Ltd, AC-2), the ionization potential was  $-5.6\text{ eV}$ . When an absorption spectrum of the compound in a thin film state was measured with an UV/VIS spectrometer (manufactured by JASCO

Corporation, V-550), an energy level of an absorption edge on the longer wavelength side of the absorption spectrum was 3.0 eV. It was determined that a HOMO level and a LUMO level of a substance represented by the structural formula (66) were -5.6 eV and -2.6 eV, respectively, and an energy gap between the HOMO level and the LUMO level was 3.0 eV.

[0178]

(Synthesis Example 2)

A synthesis method of 2,4,6-tris(10-phenyl-dihydrophenazin-5-yl)-1,3,5-triazine is described.

[0179]

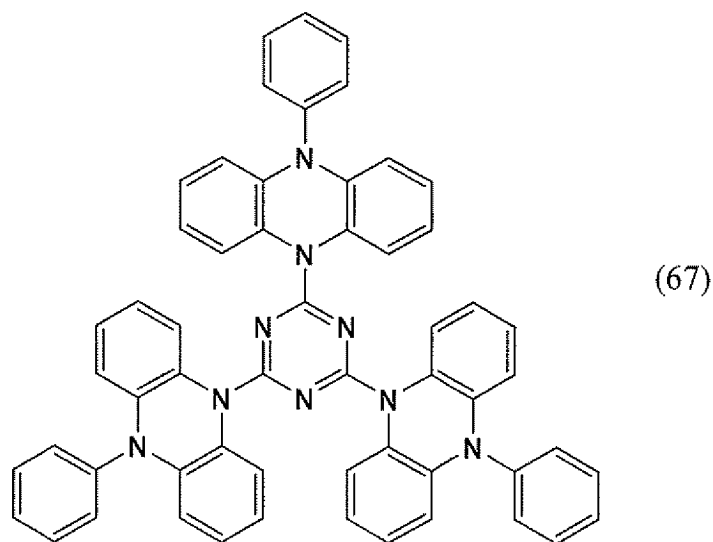
In a nitrogen atmosphere, phenyllithium (2.0M dibutylether solution, 53.0 mmol) was dropped into a dried toluene solution (180 mL) of phenazine (10.1 g, 56.0 mmol) at room temperature. After drying at room temperature for 12 hours, a dried THF solution (50 mL) of cyanuric chloride (2.40 g, 13.2 mmol) was dropped. Reflux for 6 hours was performed on a reaction mixture by heating, and water was added thereto to perform extraction with toluene. It is to be noted that an insoluble object that was precipitated during the extraction was removed by filtration. A toluene layer was washed with saturated aqueous solution, and then, drying, filtration, and concentration with magnesium sulfate were performed. Approximately 300 mL of ether was added to the obtained solid to obtain an ether insoluble part by filtration. The solid was purified by recrystallization (twice) with chloroform/ethanol, and then, a light brown compound was obtained (yield of 45 %).

[0180]

Measurement of the obtained compound by NMR (nuclear magnetic resonance) could confirm that the obtained compound was a substance (2,4,6-tris(10-phenyl-dihydrophenazin-5-yl)-1,3,5-triazine) represented by a structural formula (67).

[0181]

[Chemical Formula 19]



[0182]

The NMR (nuclear magnetic resonance) spectrum data are shown as follows.

5       <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 6.25 (dd, 6H, *J* = 1.5, 8.4 Hz), 6.77-6.86 (m, 12H), 7.36-7.58 (m, 21H)

[Brief Description of the Drawings]

[FIG. 1] a cross-sectional view illustrating a light emitting element according to the present invention.

10   [FIG. 2] a cross-sectional view illustrating a light emitting element according to the present invention.

[FIG. 3] a diagram illustrating a panel according to the present invention.

[FIG. 4] cross-sectional views illustrating pixels according to the present invention.

[FIG. 5] a cross-sectional view illustrating pixels according to the present invention.

15   [FIG. 6] a cross-sectional view illustrating pixels according to the present invention.

[FIG. 7] diagrams illustrating equivalent circuits of pixels according to the present invention.

[FIG. 8] diagrams illustrating electronic devices according to the present invention.

[Document Name] Abstract

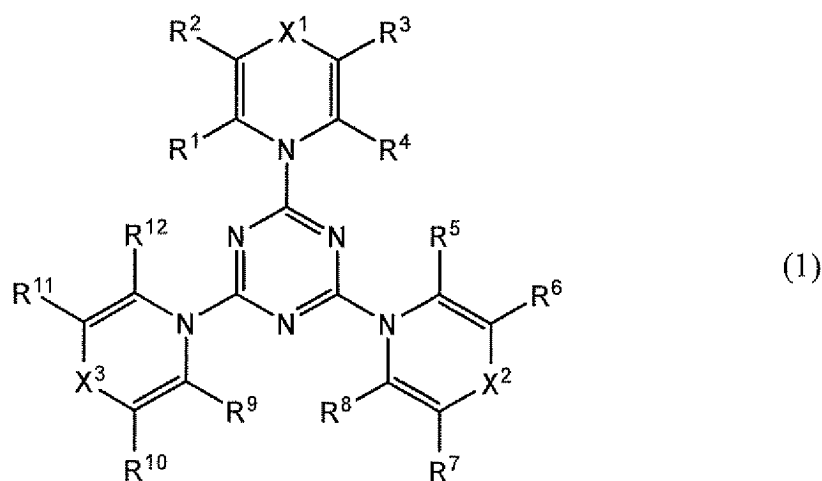
[Summary]

[Problem] It is an object to provide a light emitting element that has a different structure from that of a conventional light emitting element and includes a substance having a novel structure. It is also an object to provide a light emitting device having the light emitting element.

[Solving Means] In the view of the objects described above, the present invention has a feature of a light emitting element including a pair of electrodes, and a layer containing a triazine derivative represented by the general formula (1), and a metal oxide that is an inorganic compound, which are provided between the pair of electrodes. Further, the present invention has a feature of a light emitting device that has the light emitting element.

[Selected Drawing]

[Chemical Formula 1]



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